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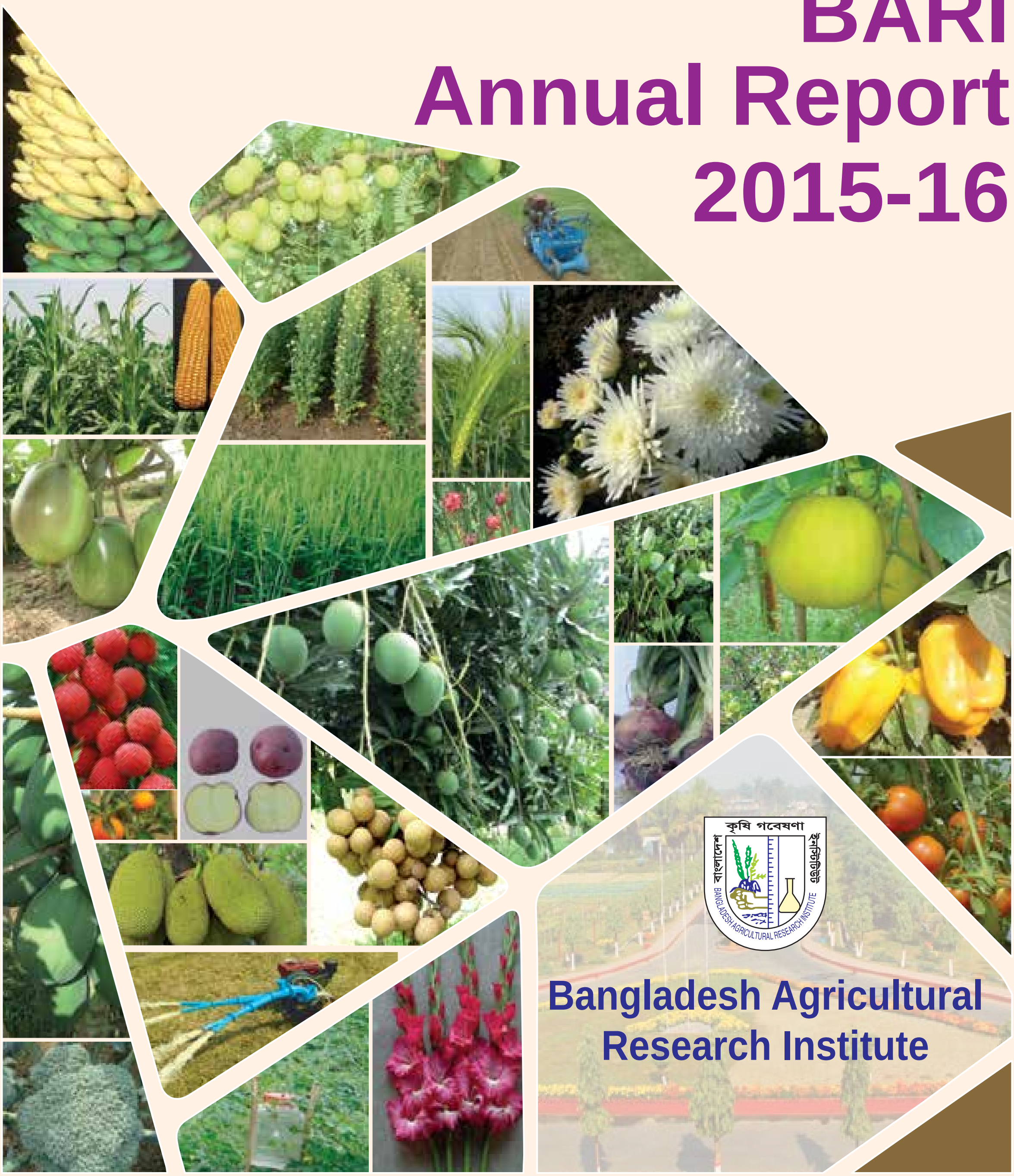
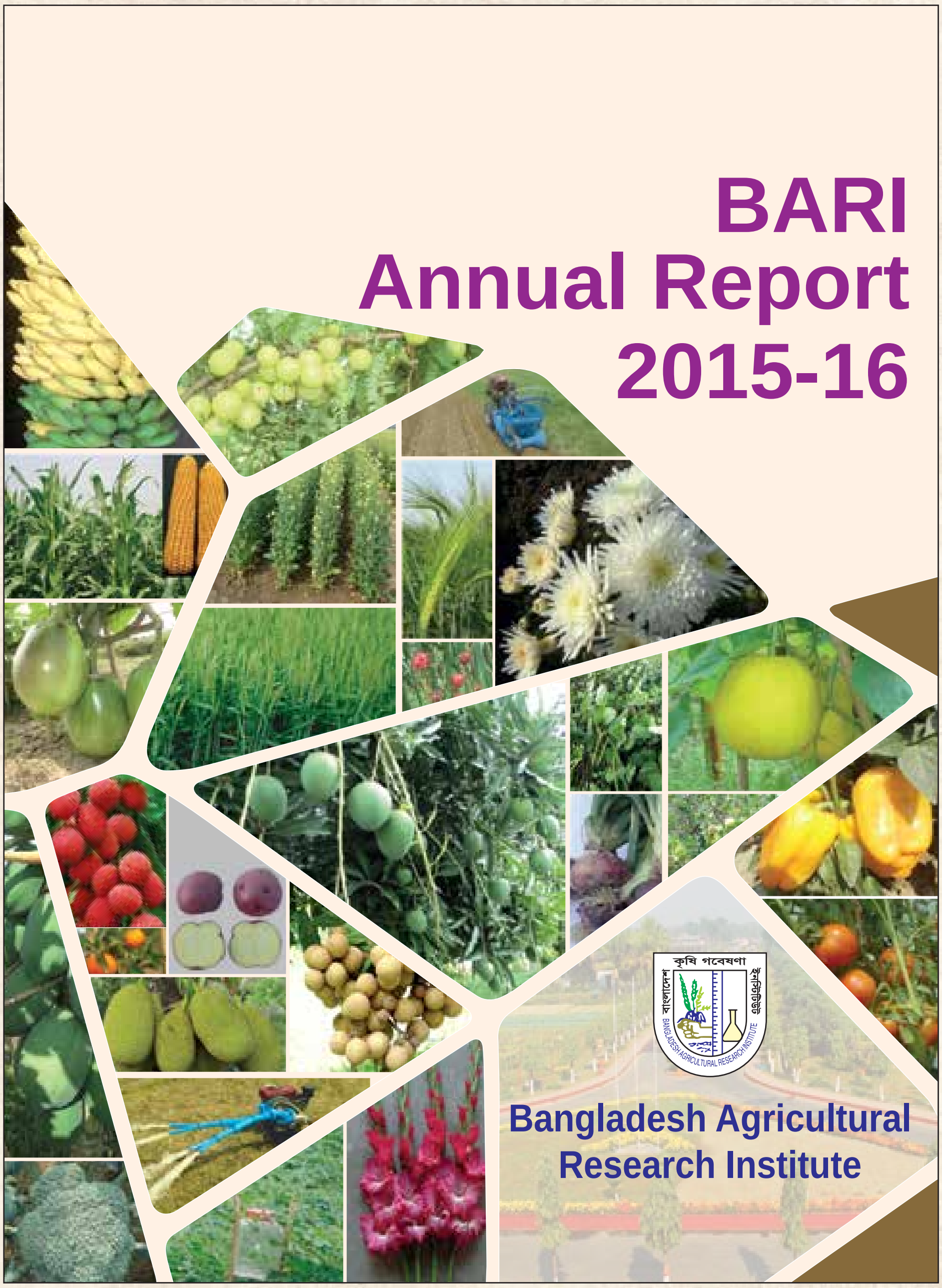
BARI
Annual Report
2015-16



Bangladesh Agricultural Research Institute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Annual Report
2015-16
Bangladesh Agricultural
Research Institute

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Foreword

This report includes the results of the experiments conducted by the scientists of the Institute during the year 2015-16. Major research areas include variety development of various crops, such as cereals (wheat, maize, millets, barly, and sorghum), tubers (potato, sweet potato, aroids etc.), oilseeds (mustard, rapeseed, groundnut, sunflower, safflower, linseed, niger etc.), pulses (grasspea, lentil, chickpea, mungbean, blackgram, cowpea, pigeonpea etc.), horticultural crops (fruits, vegetables and flowers), and spices (onion, garlic, turmeric, ginger, fenugreek, etc.). Thrust was placed on such non-commodity areas as cropping systems, soil and water management, plant nutrition, disease and pest control, production economics, development of low-cost farm tools and machinery, postharvest processing, irrigation, and farm management. Attention was focused on plant biotechnological research, improvement of floriculture and hill farming. Our scientists are engaged in developing technologies which are appropriate as well as sustainable with a view to narrowing down the gap between food demand and its production.

The annual report synopsizes the total research activities of the year under report. It is however not possible to accommodate all the conducted experiments along with their detailed narratives and data in tabular from in such a volume. So like previous years, only the major findings of the studies have been incorporated in this report. The readers can get the real flavor and information of any of the studies in brief. In case anybody wants to have all the generated data, he or she may go through the centre or divisional reports.

I express my heartfelt thanks to those who worked hard to bring this report out. I hope this report will be useful to the scientists, teachers and students, policy makers, and other who are engaged in agricultural research and development in Bangladesh.

(Dr. Md. Rafiqul Islam Mondal)
Director General


Bangladesh Map
Central Station
Regional Station
Research Centre
Sub Station
SP. Crop Station
North
INDIA
INDIA
INDIA
MYANMAR
PANCHAGARH
NILPHAMARI
THAKURGAON
DEBGANJ
LALMONIRHAT
BURIRHAT
NASHIPUR
KURIGRAM
DINAJPUR
RANGPUR
MAHIGANJ
GAIBANDHA
JOYPURHAT
SHERPUR
NAOGAON
SHIBGANJ
JAMALPUR
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HABIGANJ
MOULVIBAZAR
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NATOR
SIRAJGANJ
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JOYDEBPUR
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MANIKGANJ
DHAKA
N'GANJ
BRAHMANBARIA
CHUADANGA
RAJBARI
JHENAIDAH
FARIDPUR
MUNSHIGANJ
COMILLA
KHAGRACHARI (HILL TRACTS)
MAGURA
SARIATPUR
CHANDPUR
JESSORE
NARAIL
MADARIPUR
GOPALGANJ
FENI
BARISAL
LAXMIPUR
NOAKHALI
RANGAMATI (HILL TRACTS)
HATHAZARI
PEROJPUR
PAHARTALI
RAIKHALI
KHULNA
RAHAMATPUR
BAGERHAT
JHALAKATI
CHITTAGONG
PATUAKHALI
BHOLA
BARGUNA
BANDARBAN (HILL TRACTS)
COXS BAZAR
BAY OF BENGAL
0 10 20 30 40 50 miles
0 20 40 60 80 km

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The Director-in-charge of administration of the Institute acts as secretary of Board.

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CONTENTS

1 CEREAL CROPS

Wheat

Variety improvement

The main objective of this project is to develop high yielding wheat varieties with wide range of adaptability with a view to enhance wheat productivity in Bangladesh. Development of heat tolerant variety has been given the highest research priority under the context of global climate change. Due emphasis has also been given to develop varieties against other abiotic stresses like drought, salinity, Boron-deficiency, etc. Genetic improvement through incorporating stress adaptive traits into good agronomic background is being duly emphasized in the variety development programme. In addition, research thrust has been put forwarded towards developing varieties for improved bread making quality. Efficient deployment of resistance genes into the genotypes with good agronomic background for the major diseases like bipolaris leaf blight, leaf rust, stem rust, etc. is also considered as a priority area. The performance of newly developed wheat lines from national and international sources specially CIMMYT is being evaluated under different growing environments across the country and promising lines superior to the standard check varieties are selected.

Apart from that, Wheat Research Centre (WRC) maintains a unique crossing block having germplasm from diverse sources and those are utilized for hybridization. Segregating generations are advanced following selected bulk method. Every year hundreds of new lines are being added in the nurseries/trial for performance evaluation. Wheat research activities on variety development during 2015-16 are described in this report.

Hybridization

In order to enhance wheat production in the country, it is important to increase the yield potentiality of the upcoming varieties which can be realized through good agronomic management. Yield potential can be increased through strategic crosses based on pyramiding yield potential traits, disease resistance, physiological traits conferring tolerance to abiotic stresses, etc. in the agronomical superior adapted genotypes. The main objective of hybridization is to combine and recombine desirable genes in the background genotypes that create variability with good agronomic traits. This will be further followed up through selection and reselection of desirable plants in subsequent generation with a view to developing improved varieties.

A total of 551 single, 53 top and 77 backcrosses were made this year to incorporate the desired genes in the adapted genotypes. The hybridization programme has been conducted at five research stations viz. Dinajpur, Gazipur, Jessore, Jamalpur, and Rajshahi. The crosses made will be confirmed in next year.

Confirmation and selection in F_1 generation

The objective of this nursery was to confirm F_1 hybrids in respect to their female parents and to obtain seed for growing F_2 generation in the next season from the selected F_1 population. The nursery consisted of single, top and back cross F_1 hybrids along with female parents. F_1 hybrids along with female parents were sown on 20-30 November 2015 in the experimental farms of WRC at Dinajpur, Jessore, Gazipur, Jamalpur and Rajshahi. On the basis of phenotypic expression of hybrids with their respective female parents 534 F_1 populations were confirmed as hybrids. In addition, 36 Top cross and 68 Back cross F_1 populations were selected. The F_1 hybrids will be grown as space planted F_2 in the next year for advancing the generation and selecting the desired genotypes.

Evaluation and selection in different filial generations

The success of a hybridization programme depends on careful handling of segregating generations. It is often desirable to discard poor cross-combinations in early generation, so that adequate attention can be paid to really potential combinations. The main objective of handling segregating generations is to grow and select the desirable families and individual plants in different filial generations for further evaluation.

In the year 2015-16, selected bulk method was followed during selection in F_2 to F_6 segregating generations. Selections were based on good vigor, earliness, medium height, disease and sterility tolerance and resistance, etc. The F_2 families were thoroughly evaluated in the field and 339 families were selected out of 639. Two hundred fifty three F_3 families and 182 F_4 families were selected out of 409 and 213 families, respectively. A total of 87 F_5 families were selected from 115 families from where 1307 individual plants were selected based on field performance and physical grain characteristics. Two hundred seven F_6 families out of 949 were selected for inclusion them in Bangladesh Wheat Screening Nursery (BWSN) for next season. The selected families, individual plants, and whole plots from different generations will be grown at each station next year to select the promising ones for advancing the generations following selected bulk method.

Germplasm maintenance

One hundred forty wheat genotypes with special characteristics were selected from different trials and nurseries of various years but not recommended as varieties are maintained through this nursery. Different exotic genotypes with special features are also included in this nursery. Each entry was grown in 2.5m long 3 rows. The nursery was planted under irrigated timely sown condition at WRC, Dinajpur following recommended package of practices. A total 140 genotypes were included in this nursery. These materials with special characteristics are maintaining in this nursery for future use.

Bangladesh wheat screening nursery (BWSN)

Bangladesh Wheat Screening Nursery is an important nursery of wheat breeding program of WRC. The selected genotypes from national nurseries like Heat Tolerant Screening Nursery and international nurseries and trials are included in this nursery. All the materials of this nursery are evaluated in this nursery before testing in yield trials. The objectives of this nursery were to select high yielding, disease resistance, short stature, and early maturing suitable genotypes for inclusion in preliminary yield trial. There were two sets of BWSN.

In the BWSN-1, Sixty genotypes including three check varieties, BARI Gom 21 (Shatabdi), BARI Gom 26 and BARI Gom 30 were evaluated at the Wheat Research Centre, Dinajpur, Gazipur and Jessore under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions. There was significant difference in yield and other characters between locations and between seeding dates. The performance of all genotypes, seeding times, locations and their interactions were statistically significant for different traits. The effect of seeding times revealed that all traits were significantly influenced by seeding time. The higher yield was recorded in ITS condition (3482 kg/ha) than in ILS condition (2305 kg/ha). The effect of location revealed that all traits were significantly influenced by locations. Days to heading and days to maturity were earlier at Gazipur and that was late in Dinajpur. The number of grains/spike and Thousand Grain Weight (TGW) was significantly higher at Dinajpur than other locations. The highest yield (4097 kg/ha) was recorded in Dinajpur followed by Gazipur (2488 kg/ha). The performance of selected genotypes over locations and seeding times was statistically significant. All the selected genotypes flowered earlier than the check variety Shatabdi except E-41 which showed heading similar to BARI Gom 21 (Shatabdi). The lowest heading days were recorded in

E-5 (57 days) followed by E-15 (58 days) and E-18 (59 days). E-15 showed the shortest stature as well, along with E-17. The number of grains/spike was higher (48) in E-5 and BARI Gom 26 followed by E-59. The highest (47 g) TGW was recorded in E-11 followed by E-9 (45 g). The highest yield (3464 kg/ha) was recorded in E-6 followed by entry 49 (3403 kg/ha) and E-4 (3351 kg/ha).

The significant interaction effect for location, seeding time and genotype, was observed for yield and all other yield contributing characters except spikelets/spike. The E-11 produced highest TGW (62 g) under ITS condition at Dinajpur followed by E-9 and E-43 (58 g) under same environmental condition. The highest grain yield was obtained from E-6 (6637 kg/ha) followed by E-11 (5880 kg/ha) at Dinajpur under timely seeding environment. Based on overall performances 23 genotypes viz. E-4, E-5, E-6, E-8, E-9, E-11, E-12, E-15, E-16, E-17, E-18, E-19, E-23, E-26, E-28, E-29, E-31, E-33, E-34, E-41, E-43, E-58 and E-59 were selected for inclusion in PYT next year. The selected genotypes had high yield, bold and plump grains with better tolerance to Bipolaris leaf blight (BpLB), blast and resistant to leaf rust diseases.

Forty-eight advance lines selected from last year's ESWYT, IBWSN, HTWSN, SATYN, HTWYT, EBWYT along with check varieties BARI Gom 21 (Shatabdi), BARI Gom 26 and BARI Gom 30 as check varieties were included in BWSN-2. The experiment was conducted under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions at WRC, Dinajpur and RWRC, Rajshahi. The experiment was planted in alpha-lattice design with 2 replications for each location. There was significant difference in yield and other characters between two seeding dates and between locations. The genotypes also showed significant variation for all the traits. Based on overall performances 10 genotypes viz. E-10, E-14, E-26, E-28, E-29, E-44, E-45, E-46, E-47 and E-48 were selected for inclusion in PYT next year. The selected genotypes had high yield, bold and plump grains with better tolerance to Bipolaris leaf blight (BpLB) and resistant to leaf rust diseases.

Preliminary yield trial (PYT)

Before testing genotypes in Advanced Yield Trial (AYT)over locations the selected genotypes of BWSN are usually tested in Preliminary Yield Trial (PYT) in different agro-climatic conditions. The objective of the trial to evaluate the performance of the advance lines in comparison to the check variety for selecting high yielding disease resistant genotypes for testing in AYT next year. Preliminary yield trial was conducted at WRC Dinajpur RWRC, Gazipur BARI and RARS, Jessore during *rabi* 2015-16 and was sown in ITS and ILS condition. A total of 28 entries were evaluated with check BARI Gom 26. The trial was laid out in alpha lattiuce design with 2 replications. The performances of Dinajpur and Gazipur locations were better than Jessore since wheat was severely affected by wheat blast disease. Yield of 7 entries (E 4, 8, 13, 15, 24, 26 and 27) were better or at par the check BARRI Gom 26 (4641 Kg/ha) at ITS condition. On the other hand, yield of eight entries were at par the check variety at Gazipur location under ITS condition. The maturity days, plant height, wheat blast, BpLB& rust disease, TGW, yield, seed colour, boldness of seed and black point of seed were taken in to consideration in selecting the materials. Considering all of these criteria eleven entries were selected for evaluation in the AYT in the next year.

Advance yield trial (AYT)

The selected outstanding genotypes from Preliminary Yield Trial are included in this trial for further evaluation across different agro-ecologic conditions to confirm the stability over the environments in respect to grain yield, disease reaction, etc. Therefore, the objective of this trial was to evaluate the performance of the advance lines compared to the existing varieties and select the promising lines for further evaluation in multi-location trials at farmers' field. In the year 2015-16, eighteen advance lines of wheat along with check varieties BARI Gom 21and BARI Gom 26 were evaluated at WRC, Dinajpur, Gazipur, Jamalpur, Jessore, Ishurdi and Rajshahi in alpha-lattice design with two replications. The trial was planted under irrigated timely sown and irrigated late sown conditions. The genotypes were evaluated for yield and yield components. The effect of sowing time, location, genotypes and their different interaction levels were significant for most of the traits. The effect of seeding time, genotypes and their interactions over locations showed that the highest yield was achieved in BAW 1234 (5588 kg/ha) at Gazipur under ITS condition, followed by BAW 1243 (5122 kg/ha) at same location and condition. The highest yield at Dinajpur was recorded in BAW 1243 under ITS condition followed by BAW 1242 at same location and condition. The lowest yield was recorded in BAW 1241 (738 kg/ha) at Rajshahi under ILS condition.

All the genotypes produced the higher TGW compare to both the check varieties. Higher TGW was observed in Dinajpur for both ITS and ILS condition than all other locations. Lowest TGW was found in Jessore for all the genotypes, particularly in ILS condition due to blast diseases. Larger variation for TGW was also found in Jessore (ITS: 8-48; mean=32 and ILS: 05-31; mean=14.75) than other locations. All the selected lines produce lower yield losses due to late seeding compare to both the check varieties. The genotypes BAW 1243, BAW 1254, and BAW 1260 were finally selected for further evaluation in candidate variety trials next year

Candidate variety demonstration (CVD)

Ten promising candidate varieties were evaluated in this trial against the check varieties BARI Gom 21 and BARI Gom 26. The trial was conducted in optimum and late seeding conditions. The unit plot size was 5m x 4m at each location. The experiment was sown in Dinajpur and Gazipur during 22 November (ITS) and 25 December (ILS), 2015 in non-replicated plots. Recommended cultural practices were followed to raise the crop. The genotypes were evaluated for yield and yield components, heading, maturity, Bipolaris leaf blight tolerance, leaf rust resistance, sterility tolerance, white and bold grains etc. There was no significant yield difference among the genotypes tested. The highest mean yield was recorded in BAW 1194 (4350 kg/ha) and the lowest yield was recorded in Shatabdi (3158 kg/ha). The highest yield loss due to late seeding was found in Check variety Shatabdi (31%) followed by BAW 1203 (24%), BAW 1194 (23%) and BAW 1202 (23%) and BAW 1219 (23%) whereas the lowest yield loss was recorded in BAW 1182 due to late seeding condition. Considering overall performance five genotypes BAW 1194, BAW 1195, BAW 1203, BAW 1208 and BAW 1222 have been selected for on-farm evaluation in farmers' field next year.

Adaptive trial with advanced wheat lines

The trial was conducted in twelve locations during *rabi* season in 2015-16. The trial was conducted in OFRD and Titas of Comilla, WRC and Ranigonj of Dinajpur, RWRC of Gazipur, RARS and farmer's field of Jamalpur, RARS of Jessore, RWRC and Charghat of Rajshahi, Dopaghat of Sherpur and Mirzapur of Tangail during the *rabi* season of 2015-16. Altogether there were 12 trials in different agro-ecological zones. The design was RCB with three replications. Three advance wheat lines BAW 1182, BAW 1200 and BAW 1202 were evaluated along with check BARI Gom 24 (Prodip). Unit plot size was 20 m^2. The nursery was fertilized with NPK and S @ 100, 60, 40 and 20 kg/ha, respectively. Yield had significant variation among the genotypes in all the locations. The highest yield (5737 kg/ha) was obtained from BAW 1202 at WRC, Dinajpur and lowest yield (1957 kg/ha) from BAW 1200 at RARS, Jessore. There was no significant difference among all the genotypes including check at WRC, Dinajpur. BAW 1202 was more desirable genotype for these locations according to GGE biplot whereas Prodip performed worse. GGE biplot analysis also revealed that WRC, Dinajpur was the ideal location for genotypes evaluation followed by Jamalpur and Ranigonj, Dinajpur whereas Titas, Comilla was worse location for these genotypes.

Early heat tolerance screening nursery (3rd EHTSN)

Early heat tolerance screening nursery was established with a view to evaluating selected promising genotypes, lines from different national and international nurseries/trials for early heat tolerance and high yield potential in early seeding condition and selecting promising lines for inclusion in preliminary yield trial and or using as parent. Sixteen high yielding spring wheat genotypes including four check varieties BARI Gom 21 (Shatabdi), BARI Gom 26, BARI Gom 29 and BARI Gom 30 were evaluated at Gazipur. Rajshahi and Dinajpur under early sown condition during *rabi*, 2015-16. The experiment was undertaken to study the effect of early heat stress for yield and yield components viz; plant height, heading, maturity, TGW and grain yield. Significant variations were observed among the genotypes for all the traits studied. The genotypes varied significantly for yield and other characters over locations. On the basis of overall performance three genotypes viz; E5, E7, and E12 were finally selected for further evaluation.

Early maturing wheat screening nursery (3rd EMWSN)

Early maturity provides an escape mechanism under late incidence of high temperature stress and has been suggested as a good approach for wheat breeding to combat terminal heat stress. Early maturing wheat is very important for the rice wheat cropping system to fit the following crop after wheat. Early maturing wheat varieties can perform well under late sown condition and fit well to rice-wheat crop rotation. Hence, development of early maturing wheat line/variety has great potential to increase the area and productivity of wheat. The 3rd EMWSN was undertaken to evaluate the performance of a set of early maturing lines for yield and adaptation and select the high yielding early maturing lines for further evaluation. Sixteen early maturing spring wheat genotypes including two check varieties BARI Gom 28 and BARI Gom30 were evaluated at Gazipur and Jessore locations under optimum and late seeding condition. The experiment was undertaken to study the effect of location and seeding time on early maturing genotypes for disease tolerance (BpLB) traits, yield and yield components viz. plant height, heading, maturity, TGW and grain yield. Significant variations were observed among the genotypes for most of the traits studied. The genotypes varied significantly for yield and other characters on different seeding time over location. There was no significant advantage noticed among the genotypes for earliness, so none of them was selected for advanced genotypes. In the next season E4, E5, E11 and E16 will be further tested to verify their performance under different environmental conditions.

Drought tolerant wheat yield trial (3rd DTWYT)

A total of 25 advanced lines were included in this nursery. The experiment was sown at RWRC, Rajshahi experimental field on 22 November, 2015. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, canopy temperature etc. Significant variations were observed among the genotypes for all traits. On the basis of overall field performance and preferences of evaluation committee, six entries viz; E2, E3, E9, E10, E16 and E22 have selected for further evaluation in farmers field in the next season.

Wheat variety selection for drought prone area (2nd WVS)

A total of 8 advanced lines were included in this trial. The experiment was sown at RWRC, Rajshahi experimental field on 24 November, 2015 and Sapahar at 07 December 2015. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, etc. Significant variations were observed among the genotypes for all traits. On the basis of over all field performance and preferences of evaluation committee two entries viz., E6, and E8 have selected for further evaluation.

Collaborative studies with international organizations

Eleven international bread wheat nurseries and trials were conducted at different research stations of the Wheat Research Centre, BARI during 2015-16. The objective was to select promising lines on the basis of their yield potentiality, agronomic characteristics, disease reaction and physical grain quality. A total of 121 genotypes out of 1043 were selected from different international nurseries and trials. The selected genotypes will be further evaluated in different national nurseries and trials in next season.

Elite spring wheat yield trial (36th ESWYT)

Thirty four elite wheat genotypes selected for mega-environment one and received through CSISA project of CIMMYT, Mexico were evaluated at the Wheat Research Centre (WRC), Dinajpur in alpha-lattice design. The genotypes were evaluated for yield, heading, maturity, plant height, number of grins per spike, TGW, Bipolaris leaf blight, spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. On the basis of overall performance entry 11 and 30 had selected for further evaluation in Bangladesh wheat screening nursery next year.

International bread wheat screening nursery (48th IBWSN)

Three hundred elite wheat genotypes selected for mega-environment one and received through CSISA project of CIMMYT, Mexico were evaluated at the Wheat Research Centre (WRC), Dinajpur in non-replicated trial. Widely used BARI Gom 21 (Shatabdi) was used at each 20 genotypes interval starting from one. The genotypes were evaluated for yield, heading, plant height, Bipolaris leaf blight and spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. On the basis of overall performance five genotypes were selected for further evaluation in heat tolerant wheat yield trial next year.

Heat Tolerant Wheat Yield Trial (14th HTWYT)

The heat tolerant yield trial was conducted at WRC Dinajpur and RARS, Jessore, during *Rabi* 2015-2016 for evaluating the genotypes tolerant to heat. A total of 50 entries were sown in ILS condition and was laid out in alpha lattice design with two replications. Out of 50 entries, 11 entries were preliminary selected. In selecting the materials the environments, disease and yield were considered. The all selected material for further evaluation for heat tolerant variety development.

Semi-arid wheat yield trial (23rd SAWYT)

A field experiment was conducted as title "Semi-Arid Wheat Yield Trial (23rd SAWYT) consisted of 50 advanced, high yield potential wheat lines provided by CIMMYT, Mexico included local check variety BARI Gom 26 at RWRC, Rajshahi during *rabi* 2015-16 for evaluation yield potentiality under stress (drought) condition. The experiment was laid out in Alpha Lattice design with two replications. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis visual grain performance and others yield contribution characters the seven genotypes (E4, E6, E11, E19, E34, E35, and E42) were selected among the genotypes.

Semi-arid wheat screening nursery (33rd SAWSN)

Two hundred and eighty five elite genotypes received from CIMMYT, Mexico were evaluated against the check variety BARI Gom 26 in RWRC Rajshahi during *rab*i 2015-16. The plot size of the nursery was 2.5m long with 2 rows and the row distance was 20 cm. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, leaf rust resistance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis of visual grain quality, yield contributing traits and others agronomical performances only twenty two genotypes (E3004, E3012, E3023, E3050, E3058, E3078, E3092, E3093, E3137, E3146, E3149, E3152, E3153, E3161, E3164, E3178,E3186, E3212, E3226, E3241, E3251 and E3266) were selected from RWRC, Rajshahi for further evaluation.

Wheat yield consortium yield trial (4th WYCYT)

In order to develop pre breeding wheat materials, CIMMYT initiated consortium approach in plant breeding. Using all information available on photosynthetic and partitioning traits, CIMMYT desined hybridization schemes to combine physiological traits (PTs) with the view to achieving cumulative gene action for yield potential. These approaches have recently delivered new germplasm that expressed both higher yield and biomass compared to local checks grown at the majority of international sites where they were tested. The trial was consisted of 42 entries including one check variety BARI Gom 21. The experiment was sown on 25 November, 2015 at Dinajpur and on 28 Nov, 2015 at Gazipur. Considering different yield components, seed quality, grain yield 6 genotypes (E3, E4, E7, E36, E41 and 42) were selected. The selected genotypes will be included in national nurseries for further evaluation.

Stress adaptive trait yield nursery (5th SATYN)

Stress Adaptive Trait Yield nursery (SATYN) constituting lines selected from genetic resource collections that show favourable expression of heat adaptive traits. The nursery was consisted of 35 elite genotypes of wheat. It was grown under optimum and rainfed condition at WRC, Dinajpur, RWRC, Rajshahi and RWRC, Gazipur. The nursery was sown on 29 November in Dinajpur, 1 December in Rajshahi and 15 December 2015. The experiment was laid out in Alpha-lattice design with two replications. The unit plot size was 2.5 m long with 6 rows spaced at 20 cm. Considering different morpho-physiological characters, yield contributing characters and yield performance eight genotypes viz., E3, E5, E6, E7, E8, E10, E13, E14, E15, E20, E21, E23, E25, E30, E34 and E35 were selected for further evaluation.

Stress adaptive wheat trait yield trial (1st SATYT)

The nursery was consisted of 45 elite genotypes of wheat. It was grown under optimum and irrigated condition at WRC, Dinajpur, RARS, Jessore and RWRC, Gazipur. The nursery was sown on 26 November in Dinajpur, 15 December in Jessore and 14 December 2015. The experiment was laid out in Alpha-lattice design with two replications. Considering different morpho-physiological, yield contributing characters and yield performance 19 genotypes viz. E13, E14, E15, E16, E18, E23, E25, E26, E27, E29, E30, E31, E33, E35, E36, E42, E43, E44 and E45 were selected for further evaluation.

Harvest plus yield trial (6th HPYT)

Forty nine zinc enrich wheat genotypes from CIMMYT along with check variety BARI Gom 21 (Shatabdi) were evaluated in the experimental field of WRC Dinajpur, RWRC Gazipur and RWRC, Rajshahi in the *rabi* season 2015-16. Genotypes were tested for enriched micronutrient concentration and high yield potential with different yield contributing characters under irrigated time sown condition.Significant variation was observed for most of the traits. Among the three locations Dinajpur had the most favorable environment for wheat yield and other yield contributing traits. Considering different phenological traits, seed quality and yield potential 13 genotypes (E 4, E 7, E 8, E 10, E 15, E 16, E 18, E 28, E 30, E 35, E 36, E 42, and E 50) have selected for further evaluation. Seeds of the selected lines will be tested at HarvestPlus Bangladesh laboratory for Fe and Zn content and potential micronutrient enriched line/s will be promoted for yield trial across location.

HarvestPlus South Asia nursery (7th HPAN)

One hundred elite genotypes received from CIMMYT, Mexico were evaluated in RWRC Gazipur during *rabi* 2015-16. The plot size of the nursery was 2.5m long with 2 rows and the row distance was 20 cm. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, leaf rust resistance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis of visual grain quality, yield contributing traits and others agronomical performances only eleven genotypes (E5, E11, E13, E15, E26, E39, E57, E77, E81, E91 and E94) were selected from RWRC, Gazipur for further evaluation.

International durum yield nursery (47th IDYN)

International durum nurseries and trials from CIMMYT are the main source of durum germplasm in Bangladesh. The trial, received from CIMMYT, Mexico, was conducted to select superior durum germplasm with higher grain yields under irrigated condition for inclusion in Yield Trial next year. Fifty-three durum entries from CIMMYT along with BDW 8 as local check were evaluated at WRC, Nashipur, Dinajpur, during *rabi* 2015-16. Performances of a few durum lines were satisfactory compared to check BDW. The highest yield (4697 kg/ha) was obtained from E729. The maximum (42.0 g) thousand grain weight (TGW) was recorded in E737. On the basis of field performance, disease reaction, grain physical characteristics, and yield, only nine durum lines viz. entry E707, E713, E717, E720, E721, E728 E729, E737 and E743 were selected for further evaluation over environments. The grains of the selected durum entries were of acceptable quality and free from yellow berry marking.

PVS mother and baby trials and informal seed dissemination

Participatory research was conducted at the farmers' fields of Dinajpur, Rajshahi, Jamalpur and Tangail to facilitate farmers in selecting their preferable varieties and disseminating seeds of those in noble ways. Researches were conducted as mother and baby trials under farmers' management with the help of focus group discussion, evaluation workshops, trainings and frequent interactions. Farmers' overall score at physiological maturity stage was the highest for BAW 1203 followed by BAW 1202. Farmers' chose these genotypes for its short stature higher tillering and early maturity. The highest overall score after harvest was also recorded for BAW 1202 followed by BAW 1203 due to its bold shinny grains with higher yields. Overall, BAW1203 and BAW 1202 were the highest preferred genotypes over locations. In baby trials, BAW 1200 and BAW 1202 produced higher mean yields than the check variety BARI Gom 21 and BARI Gom 26. The line BAW 1182 produced lower yields than the check variety in all locations.

Durum yield trial (DYT)

Thirteen durum lines along with BDW 8 and BARI Gom 28 as check were evaluated at Wheat Research Centre, Dinajpur in *rabi* 2015-16. Significant variations were observed among the entries for days to heading, days to maturity, plant height, spikes /m^2, thousand grain weight and yield. Only three of the test entries yielded more than the check BDW 8 and none over the wheat check BARI Gom 28. The highest grain yield was obtained from the wheat check BARI Gom 28 (5581 kg/ha) followed by the E04 (3929 kg/ha). Thousand grain-weights of most of the test durum entries were more than that of BDW 8. The TGW of the wheat check BARI Gom 28 was the highest (50.5 g). Grains of most of the durum lines were with yellow berry marking. On the basis of field performance, disease reaction, grain physical characteristics and yield, only five promising durum entries viz. E04, E06, E08, E09 and E14 were selected for further study over environments.

Adaptive trial with advanced durum lines

Five advance durum lines along with three durum checks were evaluated at WRC, Dinajpur during *rabi* 2015-16. The yield and yield contributing traits differed significantly among the entries except grains/spike. The highest yield (4750 kg/ha) was obtained from BDW 69 and the lowest yield (2765 kg/ha) from Morocco 1. The highest (41.7 g) thousand grain weight (TGW) was also recorded in BDW 69 and the lowest (33.5 g) in BDW 57. The grains of most of the durum entries were of acceptable quality. On the basis of field performance, disease reaction, grain physical characteristics and yield, only two promising durum entries viz. BDW 69 and BDW 70 were selected for further study.

Triticale yield trial (TYT)

Eight promising triticale lines along with four checks BARI Triticale 1, BARI Triticale 2, WRF 7 and BAT 1 were evaluated at Wheat Research Centre, Dinajpur in *Rabi* 2015-16. Significant variations were observed among the entries for days to heading, grains/spike, thousand-grain weight and yield. None of the test entry out-yielded all checks. All advanced triticale genotypes produced less yield than the check variety BARI Triticale 1 and BAT 1. The highest grain yield (4701 kg/ha) was also obtained from the check BAT 1 followed by BARI Triticale 1 (4618 kg/ha). Grains of most of the triticale entries were of acceptable quality. On the basis of field performance, disease reaction, grain physical characteristics and yield, only five triticale lines viz. E06, E07, E09, E11 and E12 were selected for further study over locations.

Variety maintenance and breeder seed production

Variety maintenance and breeder seed production programme of Wheat Research Center is running based on the conception of pure line theory. The main objective of this program is to maintain purity as well as to produce standard quality of breeder seed of cultivated varieties in order to supply a handful quantity to BADC and some NGOs. In 2015-16, six bread wheat varieties namely BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were maintained in first year line and second year line at WRC, Nashipur, Dinajpur. From the second year lines, a total quantity of 2380 kg seed from the selected plots of six varieties were produced and these will be sown in next season for breeder seed production in around 23 ha and the 1425 kg seed from the remaining plots other than the selected ones will be used for truthfully labeled seed production. Seeds of second year line of previous season (2014-15) of the varieties BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were grown in large plots at WRC, Nashipur, WRSS, Thakurgaon; WRSS, Debigonj, WRSS, Rajbari, Dinajpur and RWRC, Rajshahi during rabi 2015-16. A total of 46600 kg breeder seed of BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were produced in WRC, Dinajpur, 4000 kg seed of BARI Gom 27 in ARS, Rajbari, Dinajpur and 3760 kg seed of BARI Gom 28 in RWRC, Rajshahi during 2015-16 growing season. During 2015-16 growing season, a total of 44900 kg breeder seed was distributed to BADC, NGOs & Private Seed Companies.

Zn-enrich wheat yield trial (2nd ZnWYT)

Twenty-three zinc enriched wheat genotypes, selected from 1st ZnWYT and 5th HPYT along with check varieties BARI Gom 26 and BARI Gom 28 were evaluated in the experimental field of WRC, Dinajpur, RARS, Jamalpur and RWRC, Gazipur during the *rabi* season 2015-16. Genotypes were tested for enriched zinc concentration at ICRISAT, India and selected for this study. The genotypes were grown under optimum condition with three irrigations. The experimental design was 5 X 5 alpha lattice design with 2 replications. Significant variations were observed for most of the traits studied in all three locations. Dinajpur was the most effective location for selecting genotypes based on yield and Joydebpur was most effective for thousand grain weight (TGW) in this study. Zn concentration measured in ICRISAT, India ranged from 35.1-58.1 ppm in the year 2015. Considering earliness, good agronomic traits, seed quality, yield potential and Zn content 12 genotypes E 4, E 12,E 13, E 14, E 15, E 16, E 18, E 20, E 21, E 22, E 23and E 25 have been selected for further evaluation. The selected micronutrient enriched lines will be promoted for yield trial across location.

Hybrid wheat yield trial

The performance of six Chinese hybrid lines were evaluated in order to compare with the local check variety BARI Gom 26 and to select promising lines for further evaluation. The study was conducted during *Rabi* season of 2015-16 at Wheat Research Centre, Dinajpur and Gazipur following RCB Design with three replications under irrigated timely sown condition. Data were recorded on yield and yield contributing characters. Three hybrid genotypes viz. CSW001, CSW004 and CSW005 did not flower at all. BARI Gom 26 was superior to the hybrid lines in respect of all the characters studied. None of the hybrid lines could out yield the check. The highest mean yield among the hybrid genotypes was recorded in CSW002 followed by CSW003 and CSW006.

Wheat varieties/lines screening in saline area at Benerpota, Shatkhira

Fallow land in southern Bangladesh during winter was estimated to be more than 400,000 ha which is suitable for growing wheat. High yielding, heat tolerant wheat variety having moderate level of tolerance to salinity could be adapted in this area to increase the volume of domestic wheat basket. Earlier studies showed that the salinity level in those areas ranges from 2 to beyond 20 dS/m from November to March. Generally it was observed that salinity level increased with the increase of soil dryness. Wheat can be grown in the semi saline belt but for successful cultivation, suitable variety/genotypes capable to avoid/tolerate the salinity should be identified. Keeping the above facts in mind, an experiment was conducted in two locations (Agricultural Research Station, BARI, Benarpota, Satkhira and Varasimla, Kaligonj, Satkhira) during the *rabi* season of 2015-2016 to select salinity tolerant wheat lines. There were 14 varieties/lines viz. BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29, BARI Gom 30, BAW 1135, BAW 1157, BAW 1170, BAW 1177, BAW 1182, BAW 1193, BAW 1200 and BAW 1202. BARI Gom 25 significantly gave the highest yield (3.86 t/ha) and BAW 1200 gave the lowest yield (3.34 t/ha) at the ARS, Benarpota, Satkhira where BARI Gom 25 significantly gave the highest yield (3.76 t/ha) and BAW 1202 gave the lowest yield (3.19 t/ha) at Varasimla, Kaligonj, Satkhira. The lowest level of soil salinity was (3.28 dS/m) recorded at the sowing time and the highest level of salinity was (10.72 dS/m) recorded at the harvesting stage at the ARS, BARI, Benarpota, Satkhira and in Varasimla, Kaligonj, Satkhira lowest level of soil salinity was (4.65 dS/m) recorded at the sowing time and the highest level of salinity was (14.45 dS/m) recorded at the harvesting stage.

Screening wheat against salinity under field condition at Kuakata, Patuakhali

A screening trial with different lines/varieties of wheat was conducted at Kuakata, Kalapara, Patuakhali during *rabi* season of 2015-16 to screen out suitable lines or varieties for coastal saline ecosystem. Fourteen wheat genotypes i.e. BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29, BARI Gom 30, BAW 1135, BAW 1157, BAW 1170, BAW 1177, BAW 1182, BAW 1193, BAW 1200, BAW 1202 were planted to screen out their performance in southern saline area. Salinity of the trail plots increased with time and it ranged from 2.5 to 10.3 dS/m in the whole growing period. Among the varieties/ lines BARI Gom 25 produced the highest yield (2.20 t/ha). BARI Gom 30 gave the lowest yield (1.10 t/ha). Among the lines BAW 1182 produced the highest yield (1.6 t/ha).

Long-term effect of zero tillage on soil properties and productivity of wheat-mungbean-rice cropping pattern

An investigation was made in a long-term trial with conservation agriculture with wheat-mungbean-rice (Aman) cropping pattern started from *rabi* of 2005-06 in Research Farm of Wheat Research Centre, Nashipur, Dinajpur to see the effect of long-term zero tillage on soil properties and productivity. There were 3 plots in each replication and two were assigned to zero tillage for all the 3 crops of the pattern. From 2008-09, one of the 2 zero-till plots were assigned to alternate tillage i.e., zero tillage for wheat and mungbean and then made conventionally puddled for Aman rice. Higher or at par wheat grain yields were obtained from permanent zero tillage than from conventional or alternate tillage up to 2014-15. Zero tillage or alternate tillage produced lower grain yields of mungbean, but higher biomass than conventional tillage. Grain yields of Aman rice was higher or at par in conventional tillage than in permanent zero tillage, but alternate tillage produced higher rice grain yields than zero or conventional tillage. Comparable total yields of the pattern (system yields) were found in alternate tillage with conventional tillage. Improved soil chemical properties were found in long-term permanent zero tillage.

Cultural Practices

Long-term bed planting trial for improving productivity and fertility in wheat-mungbean-rice cropping pattern

A twelve years long-term bed planting field experiment was conducted to study the productivity, soil fertility and N-use efficiency of intensified rice-wheat system by adding a third pre-rice crop, mungbean. System productivity, fertility and N-use efficiency were evaluated under five N-fertilizer levels (0, 40, 80, 100 and 120 % N of recommended dose), two straw retention (SR) (0 and 30%), and two tillage options {permanent raised bed (PRB) and conventional tillage practice (CTP)}. Permanent beds with 30% straw retention produced the highest productivity for all three crops in the sequence. Within each N rate the total system (rice-wheat-mungbean) productivity was higher with 30% SR on PRB and lowest in CTP with 0% SR. At 80% of recommended fertilizer N, mean annual system productivity was 12.5 t/ha for PRB with 30% SR, 11.2 t/ha with PRB on 0% SR and 10.3 t/ha with CTP without straw. N uptake and use efficiency were increased with increasing N levels with bed planting up to 120% N application (120 kg N/ha) in wheat, both 100% (80 kg N/ha) in rice and (20 kg N/h) in mungbean for all years. System productivity in N unfertilized plots increased when straw was retained due to increased supply and uptake of N. The results suggest that N fertilizer rates can be reduced when 30% straw is retained both from rice and wheat & full residue retention from mungbean. Soil organic matter in surface soil layers of the PRB had increased by 0.78% after thirteen years (12 rice-wheat-mungbean crop cycles) with 30% SR. Straw retention is an important component of soil management and may have long-term positive impacts on soil quality compared with conventional tillage with 0% SR. The combination of PRB with nutrients and residues retained appears to be a very promising technology for sustainable intensification of rice-wheat system in Bangladesh

Effect of bed planting and residue management on productivity of wheat-maize-rice cropping pattern

An experiment was conducted to study the productivity and soil fertility of intensified rice-wheat system by adding a third pre-rice crop, maize. The trial comprises of four packages of practices including crop residue retention, seeding methods with tillage options imposed on the component crops in wheat-maize-rice cropping pattern. The results indicated that keeping standing 30% crop residue in the field with minimum disturbance of soil had significant contribution on grain yield of wheat-maize-rice sequence compare to conventional practice of well-till without crop residue retention. System productivity and fertility were evaluated under two levels of straw retention (0 and 30%) and three tillage options (permanent raised bed, fresh bed and conventional tillage practice) in a rice-wheat-maize cropping pattern. Both fresh and permanent bed with 30% straw retention produced highest productivity, and lowest yield was also found in conventional practice with 0% straw retention.

Intercropping mustard with wheat in bed planting under rice-wheat system

This experiment was conducted at RARS, Jessore during *rabi* season of 2015-16 to examine the productivity and economic return of wheat and mustard in intercropping condition. Grain yield and yield contributing characters of wheat were significantly influenced by intercropped wheat with mustard under bed planting system. The highest grain yield of wheat (2548 kg/ha) was obtained from sole wheat treatment followed by one row mustard in between two beds of wheat (1769 kg/ha) due to intercrop effect within the two crops. The lowest grain yield of wheat (1396 kg/ha) was obtained from the treatment two rows mustard in between two bed planting of wheat. The highest seed yield of mustard (1390kg/ha) was obtained from sole mustard treatment followed by one row mustard in between two beds of wheat. The highest wheat equivalent yield and gross return was obtained from one row mustard treatment in between two beds of wheat. The highest BCR and LER were also obtained from one row mustard in between two beds of wheat.

Evaluation of new wheat genotypes under different tillage methods using participatory technology selection approach

The experiment was conducted in WRC, Nashipur, Dinajpur during 2015-16 to observe the performance of newly wheat genotypes under different tillage methods using participatory technology selection approach. Treatments were three tillage options (bed, strip and PTOS) and six wheat genotypes (5 varieties: BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29, BARI Gom 30 and one advance line: BAW 1170). Treatments were arranged in split-plot design with three replications i.e., tillage options were in main plots and genotypes were in sub-plots. Results of the study indicated that grain yield of wheat varieties differed significantly with each other in all types of tillage methods. Among the genotypes, BAW1170 gave the highest grain yield followed by BARI Gom 30, BARI Gom 28, BARI Gom 26, BARI Gom 29, and BARI Gom 27 gave the lowest. However, tillage options did not differ significantly with each other. Numerically the strip was the best method for all wheat genotypes, followed by PTOS and bed planting. The interaction effect of different wheat genotypes and tillage options also did not influence significantly. But, numerically genotype BAW1170 performed better when grown in strip till condition, followed by BARI Gom 30 and BARI Gom 26. Other three genotypes (BARI Gom 27, BARI Gom 28 and BARI Gom 29) performed better in PTOS condition.

Relay cropping of wheat with T. Aman under rice-wheat system

This experiment was conducted at WRC, RARS, Jessore during 2015-16 to ensure timely sowing of wheat and increasing productivity. All the varieties used in the trial performance better in all the characters. Maximum heading days (72 days) was recorded from BARI Gom 21 (Shatabdi) and minimum from BARI Gom 25 and BARIGom 26. The highest maturity days was recorded also from Shatabdi (107 days). Maximum spikes/m^2 meter was recorded from the variety BARI Gom 27 followed by BARI Gom28. The highest grain yield (2926 kg/ha) was produced from BARI Gom 28 in relay condition followed by BARI Gom 25. The lowest grain yield was obtained from BARI Gom 26 due to infestation of blast disease.

Development of yield model of modern wheat varieties under late sown heat stress environment

The trial was carried out in the *rabi* season of two years of 2014-15 and 2015-16 in research field of Regional Wheat Research Centre, Rajshahi. Three varieties and one advance genotype (BAW 1051, BARI Gom 26, BARI Gom 27 and BARI Gom 28) of wheat were used as test crop. One irrigated timely seeding (ITS) and three irrigated late seedings (ILS) were tested. The ITS was Nov 25, and three ILS were Dec 10, Dec 25 and Jan 10. The design followed for the trial was split-plot with 3 replications. In case of late seeding, the genotypes faced a significant level of high temperature stress that also significantly affected the required days to anthesis and maturity of all genotypes including the yield and TGW as compared to irrigated timely sowing. In the timely sowing treatment, days to anthesis decreased due to late sown heat stress condition regardless the cultivars. These phenological characteristics under heat stressed condition led the wheat cultivars to significantly lower the grain yield as compared to normal condition. In late sowing conditions (Dec 10 –Jan 10), the grain yield was reduced by 8.9-32.5 % in BARI Gom 26, 9.6-36.3% in BAW 1051, 11.0-30.5% in BARI Gom 28 and 6.7-37.0% in BARI Gom 27. It was also observed that grain yield was found to be reduced about 4.3-14.2% in BARI Gom 26, 8.1-21.9 % in BARI Gom 27, 4.2-13.4% in BARI Gom 28 and 6.5-16.3% in BAW 1051 from irrigated timely sowing condition (ITS) for each 1°C rise in average mean air temperature during booting to maturity. On the other hand, reduction percent were less for the advanced lines and new varieties. Grain yield reduction was about 1.4-2.65% in BARI Gom 28, 0.2-16.7 % in BARI Gom 27 and 1.7-6.0% in BAW 1051.

Growth and yield of wheat varieties under raised bed system

The experiment was conducted during *Rabi* seasons of 2013-14, 2014-15 and 2015-16 at the Regional Wheat Research Centre, Rajshahi. Recently released six varieties were evaluated under raised bed system in randomized complete block design with three replications. The main objectives of this study was to select suitable varieties under bed planting method for biotic and abiotic stress encountered in wheat based cropping system in Bangladesh. The varieties were evaluated for yield, and yield components with some phenological and physiological parameters. The effects of raised bed system over three years were significant in all the parameters. The highest mean yield over tillage method (among the tested genotypes) was produced by varieties BARI Gom 23 and BARI Gom 26 followed by BARI Gom 21 (Shatabdi) variety. These genotypes produced satisfactory yields in raised bed methods. The lowest yielder varieties were BARI Gom 24 (Prodip) and BARI Gom 27. Considering the overall growth parameters, yield and other characters 3 varieties BARI Gom 23, 26 and Shatabdi have been provisionally selected for conclusive evaluation next year under raised bed system.

Study on seed quality of wheat at farmers' level

The study reported that the farmers never maintained the standard of seed quality as a result the performance of farmers' wheat seed was not in satisfactory level. The quality of the seed produced following the traditional method can meet seed standard of the country in a very limited scale. All the findings lead to indicate that farmers' knowledge and skill need to be improved if the quality of farmers' seed is to be improved.

Validation of wheat based cropping patterns in Jamalpur region

A study was conducted at Regional Agricultural Research Station, Jamalpur with some designed (alternate) wheat based cropping patterns against existing pattern started from *rabi* 2014-2015 to determine the profitability of the cropping patterns. The alternate cropping patterns were i) wheat-GM-T. Aus-T. Aman, ii) wheat-mungbean-T. Aman, iii)) potato-wheat-mungbean-T. Aman and iv) wheat-mungbean-T. Aus-T. Aman, and the farmers existing pattern was (v) wheat-jute-T. Aman. The highest wheat equivalent yield (14.37 t/ha) was found from potato-wheat-mungbean-T. Aman cropping pattern among the patterns and higher than the existing pattern. Gross return (299400/-Tk/ha), Gross margin (110950/- Tk/ha) and BCR (1.59) were also the highest from this pattern. The one year results revealed that this alternate cropping pattern was agronomically and economically more profitable than the existing pattern, and the experiment should be continued.

Screening of wheat genotypes against drought/rainfed condition

For screening of wheat genotypes against drought/rainfed (stress) condition, experiments were conducted at five locations viz. WRC, Nashipur, Dinajpur, RWRC, Shyampur, Rajshahi, RARS, Jamalpur, RARS, Jessore, and RWRC, Gazipur during November 2015 to March 2016. Eight wheat genotypes were evaluated against drought stress (without irrigation i.e. drought/rainfed condition) compared to irrigated condition (i.e. control condition. Under drought/rainfed condition grain yield was increased in BARI Gom 30 (19%), Genotype 09 (9%) and Genotype 23 (8%) among the genotypes over five locations. In case of YSI, the Genotype 09 (84%), Genotype 23 and BARI Gom 30 (75%), Genotype 30 (74%), Genotype 21 (72%) showed better results than other genotypes. In respect of STI (>1.00 or closed to 1.00 is fevered), Genotype BARI Gom 30 (0.92) showed higher value followed by Genotype 23, BARI Gom 28 (0.78), and Genotype 31 (0.77). In respect of SSI, Genotypes 09 (0.019), BARI Gom 30 (0.030), Genotypes 30 and 31 (0.031) showed lower value (≤ 1.00.) and were more or less similar with the genotypes selected on the basis of yield stability index. On the basis of yield stability index, it may be suggested that genotype BARI Gom 30, Genotype 09 and Genotype 23 might be cultivated in drought prone areas. On the other hand, genotypes which were selected through STI (BARI Gom 30 and 28, and Genotypes 23 and 31) and SSI (Genotypes 09, 30, 31 and BARI Gom 30) could be used for conventional and molecular breeding as well as biotechnological aspect to incorporate drought tolerance mechanisms through introducing specific identified gene into germplasm which will be high yielding capability for developing both high yielding as well as drought tolerant cultivars.

Crop nutrition

Direct and residual effects of applied organic and inorganic fertilizers on yield and soil properties in a wheat-rice cropping pattern

Integrated use of chemical fertilizers with organic matter can help for a sustainable and, environmentally sound agriculture production in soils low in organic matter. A 19 years study with rice and wheat cropping pattern was conducted on a sandy loam soil at Wheat Research Centre, Nashipur, Dinajpur, Bangladesh to investigate the direct, renewed and residual effect of organic manures (OM) in combination with chemical fertilizers on crop productivity and soil fertility. The experiment was laid out with nine treatments in a randomized complete block design. The treatments were: 1) absolute control (no fertilizers, no manures), 2) 100% NPKSZn of recommended dose, 3)

75% NPKSZn of recommended dose, 4) 75% NPKSZn+ farm yard manure (FYM) applied in wheat (a direct effect for wheat and residual effect for rice), 5) 75% NPKSZn+FYM applied in both wheat and rice (a renewed effect for both continuing crops), 6) 75% NPKSZn+FYM applied in rice (a direct effect for rice and a residual effect for wheat), 7) 75% NPKSZn+ poultry manure (PM) applied in wheat (a direct for wheat and a residual effect for rice), 8) 75% NPKSZn+PM applied in both wheat and rice (a renewed effect) and 9) 75% NPKSZn+PM applied in rice (a direct effect for rice and a residual effect for wheat). The results indicated that a wheat yield-increasing trend was observed for the PM treatment both as direct and residual. There was no definite wheat yield trend for the other treatments. No definite rice yield trend was observed irrespective the treatments. The results showed that organic manures had direct and residual effects on both rice and wheat yields, but the effect of PM was dominant. Plots with FYM plus 75% NPKSZn produced equivalent or higher yields as plots applied 100% NPKSZn indicating that FYM can substitute for 25% of the inorganic fertilizers. The results also showed that OM application in both crops was not encouraging. The highest mean yield of wheat and rice was recorded in PM treatment as direct in wheat and in both crops, respectively. The total (wheat + rice) highest yield was 8871kg/ha/year recorded in PM as both crops and followed by 8809 kg/ha /year direct in wheat treatment.. The soil analysis data indicated that pH was unchanged or reduced in control and inorganic fertilizers treatments, but increased in plots with added organic manures with dominant trend in PM plots. Percent reduction of OM in plots with inorganic fertilizers treatments was observed. However, the increasing trends of OM were observed in plots organic manures received. An increasing trend was prominent in PM application treatments. Percent total N was increased in integrated use of OM with inorganic fertilizers, but reduced in control and inorganic fertilizers receiving plot treatments. The content of available P was increased dramatically in PM applied plot treatments. It was unchanged in 100% NPKSZn and reduced in control and in 75%NPKSZn. Exchangeable K was reduced in control and inorganic fertilizer treatment, but was increased in others. The available S was sustained in control and only 75% chemical fertilizers treatment and was increased in all treatments than initial. Exchangeable Ca content was higher in organic manures receiving treatments than inorganic only and the highest was found in PM as both crops plot. Soil bulk density was decreased and total porosity was increased as a result of organic manure application. However, decreasing trend of bulk density and increasing trend of total porosity were dominant with poultry manure application than FYM.

Effect of crop residues on soils properties and crop yield in wheat-rice cropping pattern

A long-term experiment was initiated during the year 2003-2004 at wheat Research Center to know the effects of crop residues on wheat-rice cropping pattern. The treatments were 1) Residues removed from the plots, 2) 1/2 residues of both wheat and rice crops remain in the plots, 3) 1/3 residues of both wheat and rice crops remain in the plots, 4) 1/2 residues of wheat remain in the plots, 5) 1/3 residues of wheat remain in the plots, 6) 1/2 residues of rice remain in the plots, 7) 1/3 residues of rice remain in the plots. Data on the yields of 11 crop cycles were taken. The rice yield was responded to addition crop residues in all the seasons. However, wheat yield was responded during 2005-2006, 2007-2008, 2010-11 and thereafter up to2014-15 to residues addition. In 2015-16, wheat yield was not responded to addition of crop residues. Although wheat yield was not significantly responded to addition of crop residues in each year, addition of crop residues produced numerically higher yield compared to residues removed treatment. The highest yields of both the crops were obtained in 1/2 residues of both the crops remaining treatment. Percent mean yield increase over the years was found as 10 and 16 in ½ residues of both crops remaining treatment than residues removed plot for wheat and rice, respectively. The soil analyses data after 5 and 9 crop cycles indicated that soil pH and S was unchanged irrespective of the treatments. In contrast, of soil pH, available P and, % OM, % total N and exchangeable K enhanced in plots where crop residues were added than crop residues removed. The highest exchangeable Ca content was found in plot where ½ residues of both crops were added.

A study on water requirement and water productivity of wheat under different tillage options

Field experiments were conducted at the farm of Wheat Research Centre (WRC), Dinajpur, Wheat Research Sub-Station, Debiganj and Agricultural Research Station, Rajbari to determine the seasonal water requirement and water use pattern of wheat in different tillage methods. The soil was light in textured at WRC and WRSS and heavy in textured ARS. The experiment was laid out in a split-plot design with 3 replications. The tillage options, i) Power tiller operated seeder (PTOS), ii) Bed planting (BP) and iii) Conventional planting (CP) were assigned in main plots and the amount of water, i) Application of water to meet 100% field capacity (FC), ii) Application of water to meet 80% field capacity (FC), iii) Application of water to meet 60% field capacity (FC) and iv) Application of water up to 4 cm height from the highest elevation of the plot for CP & PTOS and up to ridge of the bed for BP were placed in sub-plots. The field capacity was found as 26, 27 and 32% for WRC, WRSS and ARS, respectively. The bulk density was measured as 1.525, 1.530 and 1.406 /gm^3 for WRC, WRSS and ARS, respectively. The result indicating the yield was not differed by the tillage or irrigation options and their interaction effects. Percent soil moisture distribution pattern was found different among the sites and soil surfaces. Percent soil moisture was decreased with increasing soil depth at ARS, Rajbari and WRSS, Debiganj. Unlikely, % soil moisture contain was found higher in sub-surface soil compared to surface at WRC, Nashipur. Plants in bed planting condition were found as shorter (8 cm) compared to PTOS and conventional planting conditions.Water requirement to grow wheat was mostly similar among the tillage options. The irrigation option, 60% to field capacity was enough to provide water requirement of wheat throughout the growing season without yield reduction compared to other irrigation options. Two irrigations were sufficient to grow wheat in heavy textured soil like ARS, Rajbari while 3 irrigations were required in light textured soil like WRC, Dinajpur and WRSS, Debiganj. Only 318-329 litres water were required to produce 1 kg wheat while 3 irrigations were applied following irrigation option 60% to field capacity and maximum, 462-547 litres water were needed to produce 1 kg as flood using plastic pipe.

Integrated soil and nutrient management to improve the productivity of wheat-maize- rice cropping system

A field experiment was initiated at the central research farm of Bangladesh Agricultural Research Institute, Gazipur to achieve improve and sustainable productivity of an intensive wheat-maize-rice cropping system through integrated soil and nutrient management. Four levels of soil managements were tested under four nutrient levels in split plot design starting with wheat crop grown in 2009-10 season. Yield and yield contributing characters of component crops in the system were measured following standard methods. To understand the treatment effect on crops some additional studies including soil moisture content, weed growth, growth analysis of roots were made duly. Also the chemical analysis of soils were carried out following standard methods to determine the nutrient contents in soil after each cropping cycle upon rice harvest. The result indicated that soil management treatment of straw mulching had significant effect on surface soil moisture content that contributed to stand establishment both for wheat and maize crop. Rice straw mulch application either in bed or flat soil conditions was equally effective in conserving initial soil moisture, enhancing wheat root development and reducing weed growth and thereby positively influenced number of spikes/m^2 and finally grain yield of wheat. Similarly, wheat straw mulch application contributed to cobs/m^2 and grain yield of maize mainly by influencing the hydraulic properties of the soil. However, neither nutrient management nor soil management levels alone could produce the maximum yield but the combination of recommended fertilizers with 5 t/ha cow-dung couple with rice straw mulch application in wheat and wheat straw mulch application in maize resulted in maximum yield of wheat and maize. Rice yield was the maximum under nutrient level of IPNS and was not further increased due to further increase in nutrient levels of recommended fertilizers plus 5 t/ha cow-dung. The different soil management treatments imposed on wheat and maize crops had the similar effect on rice yield until 2013 (5th cropping cycle) and thereafter rice yield was significantly improved by the residual effect of mulch treatments.

Effect of conservation agricultural practices on productivity in wheat-maize-rice cropping system

The field experiment was initiated at research farm of Bangladesh Agricultural Research Institute, Gazipur starting with a wheat crop in 2010-11 that comprises four packages of conservation practices (CA) combining crop residue retention, use of bed planter, PTOS (power tiller operated seeder) and zero tillage options imposed and or super imposed on the component crops with in a wheat-maize-rice cropping system. Standing rice and wheat straw of 25 cm in height were retained in soil under conservation practice in bed and flat soil conditions. The result indicated that conservation practices of keeping standing crop residue with the minimum disturbance of soil have significant contribution on grain yield of wheat and maize compare to conventional tillage practice without crop residue retention. Conservation practices either in bed or in flat soil conditions were equally effective in improving spikes/m2 of wheat and cobs/m of maize and thereby increased wheat and maize yield. The residual effect of conservation practice those imposed in wheat and maize crop had the similar effect on the grain yield of rice up to the 3rd rice crop in the cycle and thereafter from the 4th cropping cycle, rice yield was also improved in response to residual effect of conservation practices. The Chemical analysis of the soils of experimental plots in different years indicated that available nutrient contents in soil especially P (Olsen), K, S and B were improved when CA treatment was imposed either in Bed or Flat soil conditions. The six years study demonstrated that CA could contribute to soil fertility, plant growth and establishment and finally improved the yields of component crops.

Evaluation of wheat varieties through nutrient addition trial

Field experiments were initiated at the research farms of WRC, Dinajpur, RWRC, Gazipur and RWRC, Rajshahi during 2015-16 wheat seasons to examine the responses of recently released five wheat varieties to seven levels of fertilizers in split plot design to explore the varietal potentials in improving wheat yield identifying the nutrient efficient genotype. The Maximum yield was recorded at Dinajpur followed by Rajshahi and Joydebpur. The higher yields were attributed to higher numbers of grains/spike and spikes/m^2. The main effect of genotype and the fertilizer level were significant. Also significant interactions were found among the combinations of location × fertilizer levels**,** location × nutient levels and nutrient level **×** genotypes. Among the wheat genotypes BARI GOM 30 produced the maximum yield followed by BARI GOM 28. Application of only N fertilizer was very effective in increasing wheat yield over the control for all the locations. The crop yield was significantly improved by P and K application at Dinajpur. Crop response to applied P was non-significant at Joydebpur and crop response to applied K was non-significant at Rajshahi. Yield response of wheat to applied nutrients varied due to soil types and native fertility in different locations and varietal difference of nutrient uptake and acquisition.

Study the yield potentials of promising wheat genotypes maximizing fertilizer application

A field trial was initiated in four locations, at Gazipur, Rajshahi, Dinajpur, and Jamalpur during 2014-15 wheat growing season to investigate the response of recently developed three wheat varieties and three promising advanced lines under four fertilizer levels replicating thrice in split plot design. The experimental result showed that higher fertilizer increased wheat grain yield especially by increasing number of spikes/m^2 and grains/spike. Among the genotypes BAW 1202 performed higher yield in all locations that was similar to BARI GOM 30 and BAW 1182. The effect of higher dose of fertilizers on wheat yield was varied among the locations. The yield of BARI GOM 30 and BAW 1202 were stable over the locations and this 2 genotype were more responsive to higher fertilizers.

Disease Management

Diseases are one of the major constraints to wheat production in Bangladesh. Among them, Bipolaris leaf blight (spot blotch) caused by *Bipolaris sorokiniana* (Sacc.) Shoemaker is most important. The disease occurs every year in all wheat growing areas of the country with varying degrees of severity depending on cultivar, sowing time and location. The second most important disease is leaf rust caused by *Puccinia triticina* Eriks. It may cause severe yield losses if a susceptible variety is late sown and infection occurs early in the crop season. Yellow rust caused by *P. striiformis* West. f. sp. *tritici* Eriks. & Henn. occurs occasionally with low to moderate severity. So far none of the rusts has reached an epidemic level in Bangladesh, but damaging epidemics may occur, particularly if a new virulent race develops or is introduced. Other diseases of regular occurrence are seedling blight caused by *B. sorokiniana*, foot and root rot caused by *Sclerotium rolfsii* Sacc., head blight caused by *B. sorokiniana* and black point incited mainly by *B. sorokiniana* and *Alternaria alternata* (Fr.) Keiss. However, head blight and black point were quite frequent in 2015-16. Powdery mildew caused by *Erysiphe graminis* f. sp. *tritici* has been observed since 2012 in late February with sporadic infection, but the disease was not noticed in the 2015-16 crop cycle. Unfortunately, wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 5-100% depending on cultivar and sowing times. Warm weather and rains during flowering might have played the major role for the outbreak of the disease. Some short and long term strategies have been suggested and research programmes undertaken to find out integrated disease management solutions to mitigate the threat. In 2015-16, major research thrust was given on screening and evaluation for disease resistance, testing fungicidal efficacy and disease monitoring in national and international nurseries and farmers' fields.

Evaluation of wheat genotypes against Bipolaris leaf blight under inoculated condition

Bipolaris leaf blight (BpLB) caused by *Bipolaris sorokiniana* (teliomorph: *Cochliobolus sativus*) is the most important disease of wheat in Bangladesh for its nature of damage and wide occurrence throughout the country. Evaluation of varieties or lines against different diseases under inoculated condition is an essential pre-requisite towards development of resistant varieties. The present experiment was designed to evaluate the response of the advanced wheat genotypes against Bipolaris leaf blight under inoculated condition. A total of 56 entries including susceptible and resistant checks were grown in 1m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries. The experiment was conducted in WRC, Dinajpur. Planting was done in the 2nd week of December. Recommended agronomic practices were followed for normal crop growth. Plants were inoculated by spraying with conidial suspension (10^4 conidia/ml water) of 15-day-old PDA culture of *B. sorokiniana* after heading and incubated under polyethylene cover for 48 hr. Before covering, the plants were watered to maintain high humidity inside. Data on BpLB severity was recorded as percent diseased leaf area (% DLA) from 10 flag leaves of 10 main tillers selected randomly in each plot. Disease assessment was done after 25 days of inoculation. The genotypes and lines were graded for disease reaction based on % DLA. The tested varieties and lines showed different levels of resistance and susceptibility against the disease. Among the varieties and lines tested, 5 were graded as resistant, 19 moderately resistant, 13 moderately susceptible, 8 susceptible and the rest 11 as highly susceptible.

Germplasm evaluation of wheat against Bipolaris leaf blight

A total of 128 genotypes from different sources along with checks were evaluated against BpLB under field condition of disease development. The experiment was conducted in three locations-Dinajpur, Jamalpur and Jessore. The materials were planted in 2m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries in mid December/2015 under irrigated condition. The nursery was surrounded by spreader rows composed of mixture of susceptible varieties. The design of the experiment was Alpha Lattice with two replications. Recommended fertilizers and cultural practices were followed for normal crop growth. Leaf blight severity was scored three times on double digit scale (00-99) commencing from the water ripe to early dough stage. Disease data were converted to percent diseased leaf area (% DLA) and then area under disease progress curve (AUDPC) was calculated. Wheat blast incidence was recorded in Jessore as percentage of spike infected. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield.

Out of 128 entries tested, 14 lines were selected based on AUDPC, grain yield and other agronomic characters. Among the selected lines, entry no. 23 was selected in all locations, 4 entries (34, 97, 114 and 115) in two locations and others in one location. The AUDPC of the selected lines ranged from 103 to 196, while those of the susceptible check varieties ranged from 126 to 365. Grain yields of the selected lines varied from 347 to 533 g/plot, whereas 188 to 307g/plot were obtained from the susceptible check varieties. Blast incidence of the selected entries recorded in Jessore varied from 0 to 30%. Days to heading, plant height and 1000-grain weight of the selected lines were also within acceptable limit as compared to the check varieties. Among the 128 entries evaluated, 14 lines were selected based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be subjected to artificial inoculation in the next season for final evaluation.

Helminthosporium leaf blight screening nursery

Resistance to *Helminthosporium* leaf blight (Bipolaris leaf blight) caused by *Bipolaris sorokiniana* is limited in the cultivated wheat varieties of the Indo-Gangetic Plains of south Asia. The disease becomes more severe if the crop is lodged and rainfall occurs during grain filling period. Searching of resistant sources is, therefore, very essential in order to develop variety with good level of resistance and good agronomic types. The present study was undertaken to evaluate wheat lines from CIMMYT-Mexico for resistance to *Helminthosporium* leaf blight under natural conditions of disease development. The 7th *Helminthosporium* leaf blight screening nursery consisting of 52 wheat genotypes from CIMMYT including local check varieties were evaluated against spot blotch disease in three different locations-Dinajpur, Jamalpur and Jessore under natural infection. The materials were planted in 2 m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries. Planting was done in mid December/2015 under irrigated condition. The nursery was surrounded by spreaders rows of susceptible varieties such as Kanchan, Sonalika, CIANO-79 and Kalyansona. Recommended fertilizers were applied and regular cultural practices were followed for normal crop growth. Spot blotch severity was scored on double-digit scale (00-99) and converted to percent diseased leaf area. Disease scoring was done three times commencing from the water ripe to early dough stage and AUDPC was calculated. Wheat blast incidence was recorded in Jessore as percentage of spike infected. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. Out of 52 lines tested, 8 lines were selected based on AUDPC, 1000-grain weight, grain yield and other agronomic characters assessed in three locations. Among the selected lines, entry no. 6002 and 6015 was selected in all locations and 6 entries (6001, 6003, 6009, 6026, 6028 and 6034) were selected in two locations. The AUDPC of the selected lines ranged from 202 to 496, while those of the susceptible check varieties ranged from 365 to 625. Grain yields of the selected entries varied between 249 and 408 g/plot, whereas 244 to 426 g/plot were obtained from the check varieties. Blast incidence of the selected entries recorded in Jessore varied from 0 to 10%. Days to heading, plant height and 1000-grain weight of the selected lines were within acceptable limit as compared to the check varieties. The agronomic score ranged from 3-4 among the selected lines. Among the 52 entries tested, 8 lines were selected based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be included in the heat tolerant screening nursery and subjected to artificial inoculation for final evaluation and use in the hybridization scheme in order to develop genetic diversity of *Helminthosporium* leaf blight resistance.

Stem rust resistance screening nursery

Stem rust caused by *Puccinia graminis* f. sp. *tritici* is an important disease of wheat worldwide. In Bangladesh, the disease was not observed in the last three decades, but recently in 2014 it was detected in some entries of the rust trap nurseries. So, this is not unlikely that the disease will appear on a large scale in future and cause damage to wheat. CIMMYT has developed wheat germplasm with good level of stem rust resistance and high yield potential. The materials were distributed worldwide through Stem Rust Resistance Screening Nursery (SRRSN) for direct release or use in breeding programmers to mitigate the threat of stem rust. The present study was undertaken with the objectives to evaluate the lines of the 10th SRRSN for disease reaction, yield and other agronomic characters under field condition. The 10th SRRSN consisting of 208 wheat entries from CIMMYT including local check varieties were evaluated for disease response, yield and other agronomic performances. The materials were planted in 2 m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries in the mid December in three different locations-Dinajpur, Jamalpur and Jessore. The nursery was surrounded by spreaders rows of susceptible varieties. Rust was scored on modified Cobb scale. Severity of BpLB was scored on double-digit scale (00-99) and converted to percent diseased leaf area (% DLA). Wheat blast incidence was recorded in Jessore as percentage of spike infected. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. Agronomic score (0-5) was given to individual entries for their general agronomy in the field. Among the 208 entries tested, 22 lines were selected on the basis of BpLB severity (AUDPC), leaf rust reaction, 1000-grain weight, grain yield and other agronomic characters assessed over locations. Some of the selected lines showed tMS to 10MS type disease severity and reaction to leaf rust, while check variety Prodip, Sonalika and Kanchan showed 10MS, tMS and 5MS reaction, respectively. However, no stem rust was noticed. Among the selected lines, entry no. 6002, 6069, 6142 and 6187 were selected in all locations and the entries 6033, 6070, 6094, 6146, 6161 and 6184 were selected in two locations, while the others were selected from one location. AUDPC of the selected lines ranged from 102 to 310, while the check varieties showed the AUDPC value 267 to 548. Blast incidence of the selected entries recorded in Jessore varied from 0 to 20%. Days to heading, plant height and 1000-grain weight of the selected lines were within acceptable limit as compared to the check varieties. The agronomic score was 3 out of 5 for majority of the selected lines.

Evaluation of wheat genotypes for resistance to leaf rust under inoculated condition

Leaf or brown rust caused by *Puccinia triticina* Eriks. is most important among three wheat rusts in Bangladesh. The disease occurs in all wheat growing areas of the country with varying levels of severity depending on cultivar, sowing times and locations. The disease usually appears in mid February with increasing severity between mid and late March. Late planted wheat is affected more than those planted in optimum times (15-30 November). Yield losses due to leaf rust are usually less than 10%, but can be 30% or more depending on the level of susceptibility, environmental conditions and the stage of crop development at the initial stage of infection. Under the agro-climatic conditions of Bangladesh, losses to leaf rust would be significant if a susceptible variety is grown under late sown condition. Use of resistant variety is the most dependable and economic approach for the control of rust diseases. Evaluation of breeding lines against different diseases under inoculated condition is an essential pre-requisite towards development of resistant varieties. The present experiment was designed to evaluate the response of the advanced wheat genotypes against leaf rust under inoculated condition.

A total of 58 entries including resistant and susceptible checks were planted in 1m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The experiment was conducted in WRC, Dinajpur. Planting was done in last week of December. Susceptible variety Morocco was planted in two rows after each pair of test lines and the nursery was surrounded by spreader rows of susceptible varieties. Recommended agronomic practices were followed for normal crop growth. Test entries and spreader rows were inoculated by spraying with aqueous suspension of urediospores at booting stage of the crop. Disease assessment was done between early and soft dough stages using modified Cobb scale representing severity and infection types. Lines were graded into resistance category based on disease severity.

The advanced lines showed only 0 to 20% severity with different types of disease response, while R type reaction was recorded in BARI Gom 26 with 10%, and 80% severity with susceptible reaction was displayed in Morocco. The variety, Shatabdi was completely free from leaf rust. Based on disease severity all the advanced lines tested were found resistant and moderately resistant. Good level of leaf rust resistance was found in the advanced wheat lines. All the advanced lines tested were graded as resistant and moderately resistance to leaf rust infection. Selected resistant lines will be further evaluated in 2016-17 wheat cycle for confirmation of resistance.

Assessment of yield losses due to leaf rust at different growth stages of wheat

Leaf rust caused by *Puccinia triticina* Eriks. is the second most important disease of wheat in Bangladesh. The disease usually appears in mid-February, and its severity is more in late than in optimum time planted crop. Yield losses of various degrees to this disease have been reported from home and abroad. However, the quantity of losses depends largely on the level of resistance and stage of crop development at the initial stage of infection. The popular wheat variety Prodip has become susceptible to leaf rust and is severely affected under late sown condition. Therefore, it is important to determine the losses caused to this variety due to leaf rust infection at various growth stages under different sowing dates. The leaf rust susceptible variety Prodip and Morocco were sown at seven different dates. Sowing commenced from 23 Nov. 2015 with seven days intervals. One of the two plots of both varieties under each sowing date was protected from leaf rust by spraying with Tilt 250 EC and the other was kept unprotected. Split-split-plot design was followed with sowing dates in main plot, fungicide protection in sub-plot and varieties in sub-sub-plot. Unit plot size was 3 m x 1.6 m. The experiment was surrounded by spreader rows of susceptible varieties. Spreader rows were inoculated at booting stage by spraying with aqueous suspension of urediospores to develop leaf rust epidemic. Disease severity was recorded at different growth stages using modified Cobb scale. Data were also taken on 1000-grain weight and grain yield from both sprayed and unsprayed plots, and percent losses in these parameters were calculated under different sowing dates. Significant variations in leaf rust severity, 1000-grain weight and grain yield were observed for sowing date (A), fungicide protection (B) and variety (C). Interactions between different factors were also found significant for different variables except A x B x C for grain yield and 1000-grain Weight. Losses recorded in Morocco were higher than Prodip under late sown condition. In general, disease severity and losses in grain weight and yield were higher under late planted compared to timely planted condition. An increasing trend in losses in grain weight and yield was observed with the increase in delay of sowing. Leaf rust severity and losses in 1000-grain weight and grain yield increased with the increasing delay of sowing. Losses in grain weight and yield of Morocco were higher than Prodip under both optimum and late planting conditions.

Efficacy of fungicides in controlling Bipolaris leaf blight and leaf rust of wheat

Expression of resistance to Bipolaris leaf blight is less sustained under favorable conditions of disease development in the rice-wheat cropping systems. In absence of good level of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Leaf rust of wheat caused by *Puccinia triticina Eriks*., can also be controlled with foliar application of fungicides. The present work was undertaken to evaluate the efficacy of some new fungicides of different groups in controlling Bipolaris leaf blight and leaf rust of wheat under field condition.

Six fungicides of different groups were tested for their efficacy against Bipolaris leaf blight and leaf rust of wheat. The fungicides were Tilt 250 EC (Propiconazole), Folicur EW 250, Win 5 EC (Hexaconazole), Tip top 300 EC (Difenoconazole + Propiconazole), Azcor 30.5 SC (Azoxystrobin + Difenoconazole) and Famus II (Hexaconazole + Validamycin) were tested as new fungicides. The fungicides were sprayed twice, once at heading stage and another at 15 days of heading. An unsprayed control was maintained for comparison. The susceptible variety Kanchan was used for BpLB and Morocco for leaf rust. Disease severity was scored as percent diseased leaf area (% DLA) on 10 flag leaves of 10 main tillers selected randomly in each plot. Severity of BpLB was recorded according to the scale suggested by Hetzler (1992) and leaf rust severity was scored according to modified Cobb scale. Data on grain yield per plot were recorded. Percent disease reduction and yield increase over unsprayed control were calculated. Among the six fungicides tested against Bipolaris leaf blight, all were found very effective in controlling the disease. The lowest disease severity was recorded in the plots sprayed with Win 5 EC and Tip top 300 EC, which was followed by Folicur EW 250, Tilt 250 EC, Azcor 30.5 SC and Famus II. The unsprayed plot showed the highest disease severity. The percent disease reduction by the fungicides ranged from 96 to 99% over unsprayed plot. The highest grain yield was obtained with Azcor 30.5 SC, and the increase in yield by this fungicide over unsprayed control was 49%, which was followed by Tip top 300 EC, Folicur EW 250, Famus II, Tilt 250 EC and Win 5 EC.

Significant control of leaf rust was observed with foliar sprays of the six selected fungicides. The unsprayed plot showed the highest disease severity. The lowest disease severity was recorded with Folicur EW 250, Win 5 EC and Tip top 300 EC, which was followed by Famus II and Azcor 30.5 SC and Tilt 250 EC. The fungicides controlled the disease by 99 to 100% with 135 to 224% increase in grain yield over unsprayed plot. The highest increase in grain yield was obtained with Azcor 30.5 SC, which was followed by Tip top 300 EC, Tilt 250 EC, Win 5 EC, Folicur EW 250 and Famus II. All the six selected fungicides viz. Win 5 EC, Tilt 250 EC, Folicur EW 250, Azcor 30.5 SC, Tip top 300 EC and Famus II were found very effective in controlling Bipolaris leaf blight and leaf rust of wheat. These fungicides reduced Bipolaris leaf blight by 96 to 99% with 34 to 49% increase in grain yield and leaf rust by 99 to 100% with 135 to 224% yield increase.

Adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight

Bipolaris leaf blight or spot blotch caused by *Bipolaris sorokiniana* (teliomorph: *Cochliobolus sativus*) is the most important disease of wheat in Bangladesh for its nature of damage and wide occurrence throughout the country. Yield losses are significant and can be severe if wheat is grown under late sown condition when terminal heat stress aggravates the disease severity during grain filling stages of the crop. However, the degree of disease severity and yield losses depends on variety and growing condition. Moreover, new virulence may also appear, particularly under changed climate which may affect adaptation of cultivars to existing environments. The leaf blight pathogen, *B. sorokiniana* is principally seed-transmitted in nature and also causes seedling blight, head blight and black point disease of wheat. This contributes to inoculums production throughout the crop cycle and long-term survival of the pathogen. The present experiment was undertaken to evaluate the response of some selected advanced lines along with check varieties against Bipolaris leaf blight and terminal heat stress and to assess their agronomic performances under timely and late sown conditions.

The experiment was conducted at WRC Dinajpur and laid out in split-split plot design with two replications. Two sowing dates, 25 November (optimum) and 25 December (late) were taken as main plot, two fungicide protections i.e., protected and non-protected as sub-plot and 12 lines and varieties as sub-sub plot. The lines were BAW 1260, BAW 1208, BAW 1170, BAW 1209, BAW 1182, BAW 1194, BAW 1195, BAW 1200. BAW 1202, BAW 1203 and the varieties were Kanchan and Shatabdi. The unit plot size was 2 x 1.2 m (2m long 6 rows with 20 cm spacing). The crop was protected from BpLB disease by spraying with Tilt 250 EC, a Propiconazole fungicide. The fungicide was applied 3-4 times @ 1 ml/litre of water, commencing from 35-40 days after sowing at 12-15 days intervals. Disease severity was scored three times on double-digit scale (00-99) of Saari and Prescott (1975) and converted to percent diseased leaf area (% DLA).

Variations in disease severity (AUDPC) and grain yield were found significant for sowing date (A), fungicide protection (B) and variety (C). Significantly higher disease severity was observed in unsprayed plot compared to sprayed plot. Late sowing showed higher disease severity than timely sown condition. The variety Kanchan showed the highest disease severity under both the sowing dates. The advanced line BAW 1200 showed the lowest disease severity, which was followed by Shatabdi, BAW 1170, BAW 1209 and BAW 1203. The other varieties exhibited more or less similar overall disease severity. Grain yield of wheat varied significantly among varieties and between fungicide protections.

The advanced line BAW 1202 gave the highest grain yield which was followed by BAW 1195, Shatabdi, BAW 1203, BAW 1170, BAW 1182 and BAW 1209, while the lowest grain yield was recorded in Kanchan. However, all the lines and varieties produced lower grain yields under late sown condition. The reduction in yield due to late planting was found lowest in BAW 1170 followed by BAW 1194 and and highest in BAW 1182 followed by BAW 1202, BAW 1209, BAW 1195 and Kanchan. Yield loss due to BpLB disease was found lowest in BAW 1170 and BAW 1182 followed by Shatabdi, BAW 1202, BAW 1209 and BAW 1195, while the highest yield loss was recorded in Kanchan. The reduction in yield due to late planting and BpLB disease together was also found highest in Kanchan and BAW 1200 while the lowest was recorded in BAW 1170 followed by BAW 1194, Shatabdi and BAW 1260. However, the yield reduction due to late planting was more pronounced than to BpLB disease. In general, BpLB severity was higher and grain yield was lower under late planting compared to planting in optimum time. Application of fungicide significantly reduced disease severity that resulted higher yield compared to unprotected crop. Advanced line BAW 1200 showed the lowest disease severity followed by Shatabdi, while the highest disease severity was recorded in Kanchan under both the sowing dates. The reduction in grain yield due to late planting and BpLB disease varied among different varieties. However, the reduction due late planting was relatively higher than to BpLB disease.

Monitoring in international disease trap nurseries

Regular monitoring and evaluation in different international disease trap nurseries is essential to know the existing disease situation in the country and finding new sources of resistance. Monitoring and documentation of different diseases occurring in international wheat nurseries are important to develop appropriate national disease control strategy and to collaborate with the international partners contributing to global disease management research. The disease trap nurseries were set up with the objectives to identify diseases, track pathogens and assess disease severity under the agro-climatic conditions of Bangladesh. Four different disease trap nurseries were received from ICARDA-Syria under ICARDA-CIMMYT Wheat Improvement Program and from DWR-India under SAARC collaboration. The nurseries were planted in the research fields in Six different locations: Dinajpur, Debigonj, Gazipur, Jamalpur, Ishurdi and Rajshahi. Sowing was done in last week of December according to the plan supplied for respective nurseries. The seeds of each entry were sown in 1 m long single/2-row plots with 30 cm spacing between entries. The nurseries were surrounded by spreader rows of susceptible varieties and exposed to natural condition of disease development. Recommended crop management practices were followed for normal plant growth. Modified Cobb scale representing disease severity and reaction type was used for recording rust diseases. Yellow and stem rust was not found, but leaf rust was observed with varying levels of severities. In the SAARC Nursery, leaf rust ranged from 0-20S, while it varied from 0-70S in International Leaf Rust Trap Nursery (7th ILRTN), 0-30S in International Stem Rust Trap Nursery (11th ISRTN) and 0-50S in International Yellow Rust Trap Nursery (10th IYRTN). Wide range of variability in leaf rust reaction and severity was observed on the near-isogenic lines and varieties with specific *Lr* genes included in the International Leaf Rust Trap Nursery (7th ILRTN). Disease reactions varied depending on the interactions between *Lr* genes and the virulence factors present in the existing leaf rust flora population in different locations. Majority of the single leaf rust resistance genes showed moderately susceptible to susceptible reactions. The specific leaf rust resistance genes *Lr9* and *Lr19* and *Lr28* were free from leaf rust infection in all the locations. Genes *Lr22b, Lr3, Lr3Ka, Lr3bg, Lr10, Lr11, Lr12, Lr13, Lr14b, Lr17, Lr18, Lr21, Lr22a, Lr(10, Lr27+Lr3), Lr26, Lr29, Lr30, Lr32, Lr33* and *Lr34* showed low (0-30%) disease severity with different types of reactions. Higher leaf rust severity was recorded in Ishwardi and Gazipur compared to other locations. Yellow and stem rust was not found, but leaf rust occurred mostly with low to moderate levels of disease severity over locations. Majority of the specific leaf rust resistance genes showed moderately susceptible to susceptible reactions, while the genes *Lr9, Lr19* and *Lr28* were free from infection. Therefore, combinations of race-specific and adult plant resistance genes need to be utilized to develop genetic diversity of rust resistance and achieve sustainable disease control.

Wheat rust surveillance in Bangladesh

Rusts are important diseases of wheat worldwide. Although none of the rusts has so far reached an epidemic level in Bangladesh, but there is no guarantee that damaging epidemics will not occur in future, particularly if a virulent race develops or is introduced. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of wheat rust pathogens. A total of 55 fields of the major wheat growing areas were covered in 2015-16 wheat growing season. The survey work was implemented collaborating different stations of WRC: Dinajpur, Gazipur, Jessore, Jamalpur and Rajshahi. Disease assessment was made following the modified Cobb scale. The BGRI protocols and format were used during the present survey. The 2016 was a less favorable year for wheat rusts in Bangladesh. Leaf rust was found in different wheat growing areas but with much lower disease pressure than in previous years. About 78% of the 55 fields investigated had leaf rust, and almost 81% of the infected fields showed low (<20%), 16% moderate (20-40%) and only 3% showed high (more than 40%) disease severity. Distribution of disease was also uneven and infrequent. Timely (15-30 November) planted crops largely escaped or had less disease compared to late planted crops. Number of infected fields was more in the north-western wheat growing areas compared to other parts of the country. The predominant cultivar Prodip showed low to high disease levels with S type reactions, whereas BARI Gom 26, BWSN-21, Mixture and Unknown displayed low to moderate disease severity with MSS type responses. BARI Gom 25 and BARI Gom 29 showed low disease severity with MRMS reaction. The cultivar Sisson showed high level of disease severity with S type of reaction. The varieties Shatabdi, Bijoy, BARI Gom 27, BARI Gom 28, BARI Gom 30 and Swarna were free from leaf rust infection. Stem rust and yellow rust was not found in any of the wheat growing areas surveyed. Yellow rust is infrequent in Bangladesh, but does occur occasionally with sporadic infection, particularly on susceptible variety Morocco. Stem rust and yellow rust was not found, but leaf rust was observed mostly with low disease severities. This does not indicate that virulent races of rust pathogens will not emerge and inflict severe damage in future. Therefore, rust survey and monitoring needs to be continued in order to adopt appropriate management approach to mitigate rust epidemic. Breeding resistant varieties and quick replacement of the susceptible cultivars would be the most economic and dependable control strategy. As an interim measure, fungicide may be applied for crop protection if a susceptible variety is grown.

Farm Mechanization

Effect of fertilizer placement in different depth for different tillage options on wheat yield

Resource conserving technologies (RCT) is introducing among the farmers and farmers are showing interest to grow crop with RCT because it reduces cultivation cost, degrading soil and saves water without crop yields sacrificed. RCT offers to plant wheat timely also. RCT is needed for farming due to scarcity and high cost of labour and for reducing cultivation cost. Zero Till, bed planting, strip tillage and PTOS tillage options are known as RCT. However, for getting expected crop yields with RCT a full package of production technology especially fertilizers management should be provided. Broadcasting fertilizer enhances their losses in RCT tillage options especially in zero-till and bed planting practices. On the other hand, there are many evidences fertilizer placement increases fertilizer use efficiency than broadcast. The work on fertilizer management such as fertilizer placement in different depth with RCT is rare in this country. An experiment was conducted at the farm of Wheat Research Centre, Nashipur, Dinajpur to develop a fertilizer application related device for existing seeder available in Bangladesh, to find out the effect of depth of fertilizer placement and the best fertilizer management in RCT under different tillage options for wheat production. The experiment was laid out in a split-split plot design with three replications. The treatments were: in main plots - four tillage methods (Power Tiller Operated Seeder (PTOS), (ii) Bed planting, (iii) Strip tillage, (iv) Conventional); in sub-plot - two depths of fertilizer placement (4±1 and 6±1cm) and in sub-sub plots - two fertilizers doses (100% and 75% recommended fertilizer) (RF). Results of the study indicated that grain yield of wheat was not influenced significantly by the interaction effect of fertilizer doses applied in different depth under different tillage options. Numerically higher grain was recorded in the plots where 4±1 cm depth under PTOS tillage system the lower yield was found in bed planting system in 6±1 cm depths. Interaction effect showed plant population after 45 days, spike/m^2 and grain/spike were significant while remaining parameters were not significant.

Technology validation and transfer

Demonstration of newly released wheat varieties

Wheat is the second most important cereal crop after rice in Bangladesh and its consumption is increasing 3% per year. The tragic irony is that the wheat production in the country 1.4 million tons, which is much bellow than the annual requirement. This deficit accounts about 75% of country's annual consumption and it is met, through imports. For increasing wheat production in Bangladesh, it is very important to adopt new technologies recommended by Wheat Research Centre (WRC). Use of power tiller operated seeder (PTOS) to confirm timely seeding and use of wheat thresher is also important to save the quality of seeds from early monsoon. WRC has released 30 varieties in conventional breeding approach and most of the later released varieties are better than previous one in respect of yield, disease and terminal heat tolerance. But those varieties and other technologies are not being adopted by the farmers in a satisfactory rate due to their inadequate knowledge about the varieties and technologies and insufficient extension efforts.

Technology transfer programmes were undertaken by Wheat Research Centre during 2015-16 to enhance technology adoption, get feed back from farmers and extension officials and increase wheat yields reducing yield gap by minimizing farmers' knowledge gap. Technologies were transferred through demonstrations, seed dissemination, trainings, field days, visits, publications, etc. Nine hundred eighteen demonstrations were conducted with 6 newly released wheat varieties viz., BARI Gom 25 & BARI Gom 26 (released in 2010), BARI Gom 27 & BARI Gom 28 (released in 2012) and BARI Gom 29 & BARI Gom 30 (released in 2014) in the farmers' fields of forty districts out of sixty four under 8 agricultural regions in 2015-16. The mean yield of all the six varieties over locations was 3.2 t/ha. The highest mean yield was recorded in BARI Gom 28 (3.33 t /ha) followed by BARI Gom 30 (3.23 t/ha) and BARI Gom 25 (3.2 t /ha). There were no significant differences among these 3 varieties. BARI Gom 27 had the lowest yield. Considering region, the highest yield was obtained from Rangpur region (3.57 t /ha) followed by Mymensingh region (3.48 t /ha) and Dhaka regions (3.4 t/ha). The yield at Jessore was lowest (24 t/ha). The mean yield of wheat under farmers' management was 2.65 t /ha and overall mean yield of the new six varieties was 3.2 t /ha. The difference between these two yields (yield gap) was 20.75%. So, the yield gap between block demonstration in farmers' field and neighbouring farmers' fields yield can remarkably be eliminated using good seeds of good varieties, seeding in optimum time and using recommended fertilizers, irrigations and other management practices. About 20 tons of seed preserved by demonstration farmers and 36400 farmers of the same and neighbouring villages visited the demonstrations.

Yield maximization demonstration

Seed is the most important input but, it needs long time to reach the farmers through public channel. When the seeds reach to the farmers, many varieties start degenerate; as a result, the farmers could not harvest the full benefit of the new varieties. Therefore, participatory scaling up seed dissemination of new varieties is very important for rapid spread of a variety, as well as, increase varietals diversity. The main objective of yield maximization demonstration is to show the superiority of new varieties and recommended technologies. BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were demonstrated in 1.50 acre block (each variety in 25 decimal plots) at farmer's field of Thakurgaon, Rajshahi, Brahmanbaria, Jessore and Jamalpur. Recommended dose of fertilizers and seeds were supplied to each farmer of those villages for establishing the demonstration with the condition of preserving and selling the product as seeds. The scientists of WRC helped them update their knowledge regarding good seeds, good varieties, optimum seeding time, optimum doses of fertilizers, irrigations and other management practices through training and field visits to maximize the yield of the new varieties of wheat. Seeding of the demonstration plots was done during 20 November to 05 December 2015. The data on yield of demonstration plots and seed preservation were taken. The yield of wheat that was received by farmers with their own management practices was also taken to quantify the yield gap between the WRC recommended practices with the farmers' practices.

Yield was recorded from demonstration and neighbouring farmers' plots. The highest mean yield over locations was recorded in BARI Gom 26 (3605 kg/ha) followed by BARI Gom 29 (3463 kg/ha). The mean yield of wheat under farmers' management was 2709 kg/ha and overall mean yield of the new six varieties was 3370 kg/ha. The difference between these two yields (yield gap) was 24.40%. So, the result indicated that yield gap between block demonstration in farmers' field and neighbouring farmers' fields yield can remarkably be eliminated using good seeds of good varieties, seeding in optimum time and using recommended fertilizers, irrigations and other management practices.

Up scaling of new wheat varieties

The trial was conducted in 40 farmer's field of 40 villages of Rangpur, Nilphamari, Kurigram and Lalmonirhat in a cluster form. The selected farmers grew wheat in 20 decimal land of a variety using their own management with supervision and suggestion of researchers and DAE personnel. Seed of the wheat varieties treated with Provax-200 with recommended dose of fertilizers were supplied to the farmers from IAP Project. Significant higher yield was obtained from BARI Gom 25 (3753 kg/ha) over the variety used by the farmers (3010 kg/ha). Significant higher yield was also obtained from BARI Gom 26 (4183 kg/ha) over the variety used by the farmers mostly Shatabdi/Prodip/BARI Gom 25/26 (3121 kg/ha). Significantly higher yield was also obtained from BARI Gom 28 (4222 kg/ha) over the variety used by the farmers (3121 kg/ha). Significantly higher yield was also obtained from BARI Gom 29 (4153 kg/ha) over the variety used by the farmers (2674 kg/ha). Significantly higher yield was also obtained from BARI Gom 30 (4127 kg/ha) over the variety used by the farmers (2805 kg/ha). BARI Gom 25, BARI Gom 26, BARI Gom 28, BARI Gom 29 and BARI Gom 30 yielded 24.7 %, 34.0 %, 35.3 %, 55.3 % and 47.1 % respectively more than the variety used by the neighbouring farmers. About 900 kg seed of BARI Gom 25, 985 kg seed of BARI Gom 26, 560 kg seed of BARI Gom 28, 750 kg seed of BARI Gom 29 and 790 kg seed of BARI Gom 30 were preserved by the farmers involved in these trials.

Up- scalling of power tiller operated seeder (PTOS) and bed planter

Wheat Research Centre, BARI has developed small farm machinery and these are tested in the research station as well as in the farmer's field with the collaboration of international partners. In field demonstrations, it is clearly proved that wheat; rice and pulses can be planted immediately after harvesting of T. aman rice. These implements capable of shorten the turnaround time and ensure timely planting which is the prerequisite of successful crop production. It is now required to expand the machinery use much scale among the farmers for increasing cropping intensity, sustaining crop yield and enhance farmer's income. So, this study has been undertaken to popularize and extend the machinery like PTOS and Bed Planter for wheat seeding among the farmers. Increase cropping intensity, sustain crop yield and enhance farmer's income through the use of developed power tiller operated seeder. PTOS is being used for different crop seeding along with seed bed preparation. Two trials were conducted at two villages of Kurigram and Lalmonirhat district under IAP Project. Power tiller operated seeder (PTOS) and bed planter were used for planting wheat directly in the farmer's field. Seed of the wheat varieties treated with Provax-200 with recommended dose of fertilizers were supplied to the farmers from IAPP. Fertilizers were broadcasted before seeding. There were huge yield difference between seeding by PTOS and conventional method used by the farmers. Yield of wheat by PTOS, Bed Planter and farmer's practice (broadcast seeding with power tiller) were 3750 kg/ha, 3880 kg/ha and 2660 kg/ha, respectively. Yield of wheat seeding by PTOS was 40.98 % higher over farmer's practice. Whereas, the yield of wheat seeding by Power tiller operated bed planter was 3880 kg/ha. Yield of wheat seeding by bed planter was 45.86 % higher over farmer's seeding practice. About 150 kg seed of BARI Gom 26 were preserved by farmers involved with the trials.

Training

Farmers, Government and NGO personnel were trained to make them familiar with the new wheat varieties, modern crop management practices, seed preservation techniques and mechanization in wheat cultivation. Training program for farmers, extension officers, young scientists, WRC field staffs, NGO personnel and others were conducted through audio-visual aids, demonstrations, lectures, group discussions, training classes, field days, motivational tours etc. by wheat scientists.

A total of 2165 personnel from different organizations attended training programmes of Wheat Research Centre given in different aspects during 2015-16. Out of those, farmers were 1637, SAAO/SSA/SA and NGO's field staff 528 were trained on wheat technologies and 162 were extension and NGO Officers were also present as observer. Trainings were imparted on new wheat variety demonstration, dual-purpose triticale variety demonstration, wheat improvement, wheat research management, wheat seed production and preservation technologies, etc.

Workshops

Wheat Research Centre organized one workshop during 2015-16 on program planning held at WRC, Dinajpur in June, 2016. Thirty three scientists engaged in wheat research from RARS, RWRC and WRC participated in the workshop. Scientist from different discipline presented their proposed research programmme for 2015-16 wheat growing season. All the scientists actively participated and made different comments and suggestions. Upon critical discussion, research programme was finalized.

Field days, visits and publications

A group of scientists and DAE personnel visited the demonstrations and seed production plots several times and were impressed to see the plots. A good number of visitors both from home and abroad also visited the on-station and on-farm activities of WRC. Students from different college and universities, WRC technologies were presented to them during their visit. Four field days were organized by WRC, Dinajpur under IAPP in seed production and block demonstration plots where about 400 farmers and 40 DAE, NGO & related personnel and four local people representatives were present. Three field days were also organized by RWRC, Rajshahi under different projects in seed production and block demonstration plots where about 350 farmers and 12 DAE, NGO & related personnel were present. The participating farmers in the field days were very much interested to cultivate new varieties of wheat. Coloured pictorial leaflets on BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 were distributed among the farmers and related personnel.

Dinajpur, Rangpur and Rajshahi regions had higher yields than other regions. In most cases this was due to optimum time of seeding. Though, there were some variations in yields among the genotypes, the farmers preserved seeds of all new varieties for next year. This will increase wheat yield and varietal diversity which are also important from the view point of disease epidemic. BARI Gom 26 was found the most stable and BARI Gom 27 was the most responsive genotypes to changing production environments. Yield maximization demonstration in large plots in farmers' fields proved that near about 0.70 ton/ha yield can be increased in farmers' field by using good seeds of new varieties, recommended fertilizers use with irrigation, etc. Good quantity seeds of new six varieties have been made available to the farmers through different technology transfer activities. This will help rapid dissemination of new varieties of wheat.

Maize

A. Characterization & Maintenance of Germplasm

Maintenance and characterization of exotic maize inbred lines

Two hundred and three exotic inbred lines comprising Set-I: 47, Set-III: 27 and Set-VII: 58 inbred received from CIMMYT, Mexico; Set-IV: 37 and Set-V: 34 exotic inbred lines received from CIMMYT, Zimbabwe were characterized following CIMMYT descriptors and maintained through selfing to increase seeds for using in future breeding program.

Maintenance of exotic and locally developed inbred lines of maize (Set IV & II)

A total of 13 locally developed inbred lines (Set IV) and another 38 BARI introduced lines (set II) were sown during rabi 2015-16 to maintain their quality and purity. Each inbred line was selfed by hand pollination and a total of 13.07 kg seeds were preserved for future breeding program.

B. Development of Source population & Inbred lines

Genetic diversity in inbred lines of maize

Fifty eight inbred lines of maize received from CIMMYT, Mexico were characterized based on different morphological traits and yield. Multivariate analysis was performed to classify the lines. All the genotypes were grouped into seven clusters. Cluster II and cluster VII were the largest comprising of twelve genotypes each. Cluster V had the highest where as VI had the lowest intra cluster distance. The highest inter-cluster distance was observed between clusters V and VI. It is expected that inbred lines belonging high to medium D^2 value tend to produce high heterosis for yield.

Development of base population in maize (2 Sets)

The experiment was conducted with balanced bulk of 5th cycle seeds and15 new commercial hybrids for both two groups, based on two objectives (i) medium height and high yield goal and (ii) dwarf and earliness. Both sets were planted and random mated in isolation at BARI Gazipur during rabi 2015-16 for the development of broad based source populations in maize. For the purpose of next cycle of selection, finally 100 ears were selected separately from the two groups and preserved carefully. The balanced bulked seeds of these two populations would be grown separately in isolation for selection of the two desirable source populations in the coming rabi season.

Recycling for development of maize inbred lines (2 Sets)

Seeds of Dream Sweet and Dream Sweet-3 sweet corn hybrids were grown in two sets separately to advance them from S_0 to S_1 generation. Sufficient numbers of plants were selfed and finally 70 and 76 selfed ears were selected from Dream Sweet and Dream Sweet -3, respectively. The selected ears were dried properly and kept separately in store for advancing in the next rabi season.

Advancing S_1 to S_7 generation of field corn, pop corn, sweet corn and baby corn (27 Sets)

The balanced bulk seeds of S_1 baby corn and field corn (Set I: Baby Star and Set II: Hybrid IM 8013) were advanced to S_2 generation for developing superior inbred lines. Variations were observed in different morphological traits among the S_1 lines in each set. About 100 plants from each sets were selfed and finally 66 and 50 selfed ears were selected from set I and set II, respectively. Selected ears were dried properly and kept separately in store for advancing to S_3 generation in the next rabi season.

The balanced bulk seeds of S_2 field corn, pop corn and sweet corn lines of eight sets (set I: Early and dwarf line, set II: Medium height and high yield goal, set III: American popcorn, set IV: Swiss pop corn, set V: Super Sweet corn, set VI: 9120, set VII: Titan and set VIII: Multiparent synthetic (MPS) line) were sown separately and advanced to S_3 generation through selfing. Variations were found among the S_2 lines for different traits in each set. Finally 7.6 kg, 3.9kg, 1.7kg, 9.7kg, 1.8kg, 3.3kg, 6.2kg and 11.43kg selfed seeds were harvested respectively, from early and dwarf line, high yielding line, American pop corn, Swiss popcorn, super sweet, 9120, Titan and MPS. The seeds were stored separately for advancing to S_4 generation following ear to row method in the next rabi season. A part would also be used for making line × tester crossing.

Six sets of S_3 lines balanced bulk seeds of field corn, sweet corn and pop corn viz. Arun 4, 981, pinnacle, one set of pop corn variety Pop Corn Nepal and two sets of sweet corn variety Seeda New and BARI sweet corn 1 were advanced to S_4 generation through selfing in order to develop superior inbred lines. Variations were found among the S_3 lines in each set for different traits. The selected S_3 plants in each set were selfed. Selected materials were stored separately for advancing to S_4 generation following ear to row method in the next rabi season.

Two sets of field corn varieties 981 (29 lines) and Pioneer (30 lines) were advanced to S_5 generation through selfing following ear to row method in order to develop superior inbred line(s). Few variation was found among the S_3 lines of each set for different traits studied. The selected S_4 plants were selfed. The S_5 seeds from selfed plants were collected and stored for further advancement in the next rabi season.

Two sets of S_5 lines of field corn varieties viz. 7074 and 981 and two sets of popcorn varieties PCB/10 and Thai popcorn were advanced to S_6 generation through selfing in order to develop superior inbred lines. Small variations were found among the S_5 lines in each set for different traits. Selected salfed materials were stored separately for advancing to S_6 generation in the next rabi season. A part of the materials would also be used for line×tester crossing and North Carolina Design II crossing.

Four sets of S_6 lines balanced bulk seeds of field corn varieties viz. Pinacale, QY-11, 900M Gold and Pacific-60 were advanced to S_7 generation through selfing in order to develop superior inbred lines. Variations were not found with in the lines among the S_6 lines in each set for different traits. Selected S_6 plants were selfed. The S_7 seeds from selfed plants were stored separately for maintenance and future use.

C. Evaluation of Inbred lines through line × tester method

Evaluation of field corn & pop corn hybrids through line × tester method (9 sets)

a) Field corn

Set I: Twenty eight hybrids were evaluated using line (8) × tester (3) method for selection of superior hybrids. The 24 F_1's, 8 lines and 3 testers along with 3 checks BARI Hybrid Maize 9, NK 40 and 981 were grown in an alpha lattice design with two replications at Gazipur. Three female parents and one tester Utn/S_4-6 was found good combiner for yield. The crosses with high SCA effect for grain yield were evolved from high × low general combiner parents which revealed additive × dominance type of gene action. The cross combinations 7074/S_4-1× Pioneer/S_4-4, 7074/S_4-5× 981/S_4-P-5, 7074/S_4-11× 981/S_4-P-5 and 7074/S_4-13× Pioneer/S_4-4 having higher positive SCA effect with high mean values of yield might be used for obtaining high yielding hybrids.

Set II: Twelve S_7 lines of commercial hybrid 900M were crossed with 3 testers in a Line × Tester mating design resulting 36 crosses along with the parents and three checks BARI Hybrid Maize 9, Pioneer 30V92 and NK 40 were evaluated in an alpha lattice design with two replications at Gazipur. On the basis of GCA effect, two inbred lines namely 9MS/S_7-9 and 9MS/S_7-16 were found to be the best parents as they had significantly desirable GCA effects for most of the characters including yield. However, three cross combinations 9MS/S_7-16×981/S_3-25, 9MS/S_7-9×Pinacle/S_5-4 and 9MS/S_7-16×Pinacle/S_5-4 were found promising according to SCA effect, mean performance and standard heterosis could be utilized for enhancing hybrid production.

Set III: Ten S_5 lines of commercial hybrid NT 6323 were crossed with 2 testers in a Line × Tester mating design and the resulting 20 crosses along with the parents and commercial checks BARI Hybrid Maize 9, NK 40 and 900M Gold were evaluated in an alpha lattice design with two replications at Gazipur. Among the parents NT 6323/S_5-27-1, NT 6323/S_5-44-1, and NT 6323/S_5-50-1 were found good general combiners for grain yield and some of the important yield contributing characters. Crosses NT 6323/S_5-50-1 ×BIL 79, NT6323/S_5-44-1×BIL28 and NT 6323/S_5-27-1 × BIL 28 showed high SCA effects for grain yield along with high mean.

Set IV: Twelve S_4 lines of commercial hybrid 981 were used as female and crossed with 2 testers (9MS/S_7-5 and 9MS/S_7-9) as male parent in a Line × Tester mating design to generate 24 crosses and were evaluated with the parents as well as standard checks NK 40 and 900 M GOLD in an alpha lattice design with two replications at Gazipur. Among the lines 981/S_4-17-1, 981/S_4-27-1-1, 981/S_4-31-1, 981/S_4-61-1 and one tester 9MS/S_7-9 were good general combiners for grain yield and some of the important yield contributing characters. Cross 981/S_4-17-1 × 9MS/S_7-9 showed positive SCA effects for grain yield along with the highest mean value.

Set V: The experimental materials comprised of ten selected S_5 generation lines of field corn (as female parents) and two S_7 line of field corn 900M/S_7-4 and 900M/S_7-5 as tester. Total 20 cross combinations were made through Line × Tester mating design during 2014-15. The 20 F_1's along with the parents, testers and three checks (NK40, 900M Gold and 981) were sown following alpha lattice design with two replications at Gazipur in 2015-16. Significant and positive GCA effect was observed in pac/S_5-17, Utn/S_5-15, Utn/S_5-3 and Utn/S_5-8. These lines could be used in future breeding program. Significant and positive SCA was observed in the crosses Utn/S_5-15 × 900M/S_7-5, Utn/S_5-3 × 900M/S_7-4, Utn/S_5-14 × 900M/S_7-5, Pac/S_5-10 × 900M/S_7-4, Pac/S_5-9 × 900M/S_7-5 and Pac/S_5-17 × 900M/S_7-5 with high mean of yield.

Set VI: A line × tester analysis involving forty eight test-crosses generated by crossing 24 S_3 inbred lines of maize with two testers and two standard checks were evaluated following alpha lattice design with two replications at Gazipur. The crosses with significant and positive specific combining ability effect for grain yield were Line 18 × BIL 22, Line 23 × BIL 22, Line 27 × BIL 22, Line 7 × BIL 28, Line 11 × BIL 28, Line14 × BIL 28, Line 24× BIL 28, Line 25 × BIL 28, and Line 30 × BIL 28. Among those crosses Line 24× BIL 28 (11.40 t/ha), Line 18 × BIL 22 (11.30 t/ha) and Line 25 × BIL 28 (11.20 t/ha) were the top three higher yielder.

Set VII: Seventeen S_3 generation maize inbred lines (as female parents) and 2 testers (as male parents) were crossed in a line × tester fashion to generate 34 cross combinations at Gazipur. Seeds of seventeen parental lines, 34 test crosses, 2 testers (BIL 28 and 900MG/S_3-9) and two checks varieties (BARI Hybrid maize 9 and commercial hybrid, NK40) were sown following alpha lattice design with 2 replications. Five lines Pioneer S_3-15, Pioneer S_3-16, Pioneer S_3-23, Pioneer S_3-29 and Pioneer S_3-30 were found as good general combiner for grain yield and possessed high means also. The crosses with significant specific combining ability effect for grain yield were Line 6 × BIL28, Line 15 × BIL28, Line 17 × BIL28, Line pioneer S_5-20, 20 × BIL28, Line 25 × BIL28, Line 16 × 900MGS_3-9, Line 22 × 900MGS_3-9, Line 23 × 900MGS_3-9, Line 29 × 900MGS_3-9 and Line 30 × 900MGS_3-9.

b) Pop corn

Set I: Seven selected S_4 lines of Pop Corn Burst (PCB) were crossed in a line × tester method with three testers to produce 21 hybrids during rabi 2014-15. In the following year, all the hybrids were raised along with their parents and two checks (Thai pocorn and BARI khoi bhutta 1) in an alpha lattice design with two replications. The line PCB/S_4-41 was the best among the parents, showing GCA effects for yield and its contributing traits together with popping quality could be used extensively in hybrid breeding program. Furthermore, based on mean and SCA effects of yield and popping quality the cross PCB/S_4-41×Thai/S_4-24 was proved to be the best to increase the grain yield along with quality.

Set II: Ten S_4 lines of commercial hybrid Thai popcorn were crossed with 2 testers in a Line × Tester mating design. The resulting 20 crosses along with the parents and standard checks BARI khoi bhutta 1 and Thai popcorn were evaluated in an alpha lattice with two replications.The lines Thai/S_4-8 and Thai/S_4-29 were the best among the parents, showing desirable mean and GCA effects for most of yield contributing and quality traits could be used extensively in hybrid breeding program with a view to increase popcorn yield along with quality. Furthermore, based on mean and SCA effects of yield and popping quality two hybrids viz. Thai/S_4-27×T_2 and Thai/S_4-28×PCB/S_7-7 were proved to be the best for grain yield along with popping quality.

D. Combining ability and heterosis study

Study of combining ability and heterosis in maize (6 sets)

Set I: Eight diverse maize inbred lines were crossed in 8 × 8 diallel fashion excluding the reciprocals and parents. The resulting 28 F_1s were evaluated along with four checks (981, BARI hybrid maize 9, NK-40 and Pioneer 30V92) in an alpha lattice design with three replications at Gazipur. The parent P_6 was the best general combiner for both high yield and earliness and parent P_2 and P_8 for dwarf plant type. Two crosses (P_3×P_5) and (P_6×P_8) exhibited positive SCA effects for grain yield involved high × low and high × average general combining parents.

Set II: Eight maize inbred lines were crossed in 8 × 8 diallel mating design excluding the reciprocals and parents. The resulting 28 F_1's were evaluated along with 2 local checks BHM9 & NK-40 following alpha lattice design with two replications at Gazipur. Parent P_8 was the best general combiner for yield and most of the yield contributing characters. Parents P_1 and P_4 were the best general combiner for dwarf and earliness in plant. Three crosses (P_1×P_4, P_2×P_3 and P_2×P_3, P_4×P_8) showed significant and positive SCA effect for yield involving low × low, average × average and high × low general combining parents. Two crosses (P_3×P_8 & P_4×P_8) showed positive and significant heterosis (10.32% and 9.31%) respectively as compare to standard check NK-40.

Set III: The experimental materials comprised of six selected genetically diverse advanced inbred lines developing from six commercial hybrids of different companies. These inbred lines were at different advance stage S_4, S_5 and S_7 designated as P_1 (Pacific60/S_5-5), P_2 (900M/S_7-6), P_3 (QY11/S_5-11), P_4 (900M Gold/S_5-6), P_5 (Uttaran2/S_5-21) and P_6 (7074/S_4-15) were crossed in a half diallel fashion to obtain seed of all possible 15 single crosses (excluding reciprocals). All the parents, F_1's and three commercial check hybrids namely BARI Hybrid Maize 9 (BHM 9), NK40 and Pioneer 30V92 were gown in a randomized complete block design with two replications at Gazipur. The parent P_1, P_4 & P_5 were found to be the best general combiner for yield and other characters. The significant positive SCA effects along with high mean and heterosis were found in the crosses $P_1 \times P_2$, $P_1 \times P_4$ and $P_4 \times P_5$ could be used for commercial variety development after verifying them in different locations.

Set IV: Seven maize inbred lines collected from CIMMYT (International Maize and Wheat Improvement Center) were crossed in a 7×7 diallel fashion excluding the reciprocals. The resulting 21 F_1's and their 7 parents were evaluated along with two commercial checks (900 M gold and NK40) in a alpha lattice design with two replications at Gazipur. The parental lines CML 498 and CML 395 were found to be the best general combiner for yield. The good combiner parents for different traits could be used in hybridization to improve yield as well as with desirable traits as donor parents for the accumulation of favorable genes. The significant and positive SCA effect was observed in the crosses CML 498 × CML 376, CML 498 × CML 395 and CML 376×CML 247 along with high mean could be used for commercial variety development after verifying them in different locations.

Set V: Seven diverse maize inbred lines *viz.* P_1, P_2, P_3, P_4, P_5, P_6 and P_7 were crossed in a 7×7 half diallel fashion excluding the reciprocals. The resulting 21 F_1's were evaluated along with two checks (Shuvra and BARI hybrid maize 9) in an alpha lattice design with two replications at Gazipur to study combining ability and heterosis in maize for grain yield and yield contributing characters. Parents P_3,

P_4 and P_5 were the best general combiner for high yield; parents P_2, P_5, and P_7 for earliness and parents P_1 & P_7 for dwarf plant type. Heterosis estimation was carried out using two commercial varieties Shuvra and BHM 9. Significant and positive heterosis for yield was observed in $P_1 \times P_7$, $P_2 \times P_4$, $P_3 \times P_6$ & $P_5 \times P_7$ and could be used for commercial cultivation after verifying them in different location.

Set VI: Seven diverse maize inbred lines were crossed in a diallel fashion excluding the reciprocals during the Kharif season in 2015. The resulting 21 F_1's were evaluated along with two checks (BARI hybrid maize 9 and commercial variety, NK40) in an alpha lattice design with three replications at the Regional Agricultural Research Station, Jamalpur in the following rabi season of 2015- 2016. Parents having good combining abilities for yield (P_4 and P_5); early maturity (P_1, P_2, P_6 and P_7); short plant and ear height (P_6 and P_7) and kernel weight (P_2, P_5 and P_1) could be used as donor partners for obtaining high yield and desirable traits. Significant & positive heterosis was observed 24.87% & 19.31% for yield in $P_4 \times P_5$, compared to standard check NK-40 & BHM 9. The crosses $P_4 \times P_5$ could be used for variety development after verifying them across the agro-ecological zones of Bangladesh.

Study on combining ability and heterosis in maize over locations

Seven inbred lines of maize viz. P_1, P_2, P_3, P_4, P_5, P_6 and P_7 collected from CIMMYT- Mexico, were crossed in all possible combinations (excluding reciprocals) and the resulting 21 F_1's along with 3 commercial hybrids viz. BHM9, 981 and NK40 were grown following Alpha lattice Design with 3 replications in five different environments viz. Gazipur, Burirhat, Hathazari, Rahmatpur and Jessore. The parents P_3, P_5 and P_6 were the best general combiner for high yield; parents P_6 for earliness; and parents P_1 and P_2 for dwarf plant type. Significant and positive SCA effect was observed in $P_1 \times P_2$, $P_3 \times P_4$, $P_3 \times P_7$ and $P_4 \times P_5$ for yield involving high× average and high×low general combining parents. The range of heterosis expressed by different crosses over BHM 9 was from -13.04% to 5.25 % percent for grain yield. The better performing four crosses ($P_1 \times P_5$, $P_3 \times P_6$, $P_4 \times P_5$ and $P_5 \times P_6$) showed good performance over locations.

E. Evaluation of single cross popcorn, field corn & baby corn hybrids

Evaluation of selected single cross maize hybrids

Twenty nine selected single cross maize hybrids and three local checks viz. BHM9, NK-40 & 981 were evaluated at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi 2015-16 to select better hybrids. Considering yield potentiality E3, E5, E8, E16, E21 & E27 were found promising. Among them E3 was dwarf & E16 was early. No disease infestation was noticed in the experiment among the tested entries.

Evaluation of dwarf and early maturing maize hybrids

Eleven single cross field corn hybrids were evaluated along with two commercial checks pacific 339 and NK 40. Significant differences were observed among the genotypes for all the characters studied except 1000 grain weight. Considering yield, dwarf and earliness two hybrids BMZ4 × BMZ66 and BMZ15 × BMZ66 were found promising.

Evaluation of promising maize hybrids at different agro-ecological regions of Bangladesh

The present study assessed genotype × environment interaction and stability for grain yield, days to silking and plant height with 32 hybrids across four different locations in Bangladesh during 2015-16. The AMMI model (additive main effects and multiplicative interaction) was used to select the hybrid having higher yield and other potential attributes. Significant variation for genotypes (G), environment (E) and GEI were observed for yield. The environment of Burirhat, Rangpur were very poor but Gazipur, Jamalpur and Jessore were rich for hybrid maize production. Considering the mean, bi and S^2di value, different response of adaptability were found under different environmental conditions. E3, E8 and E20 were high yielder but very unstable. The E16 was high yielder and also stable over four environments. Therefore, E19 was the most stable but medium yielder.

Evaluation of baby corn hybrids

An experiment was carried out at BARI research field, Gazipur during rabi 2015-16 with 14 locally developed baby corn hybrids along with a check variety Babystar to test their performance and select better one(s). All the traits showed significant variation. Seven crosses (BCP 271/S_4-13× BCP 271/S_4-7, BCP 271/S_4-12 × BCP 271/S_4-4, BCP 271/S_4-18 × BCP 271/S_4-6, BCP 271/S_4-18 × BCP 271/S_4-16, BCP 271/S_4-20 × BCP 271/S_4-6, BCP 271/S_4-9× BCP 271/S_4-19 and BCP 271/S_4-20× BCP 271/S_4-19) were selected based on number of cobs per plant, interval of cob harvesting, yield, earliness and other desirable agronomic traits.

Evaluation of selected pop corn hybrids at different agro-ecological regions of Bangladesh

Fourteen locally developed selected popcorn hybrids along with two popcorn check varieties were assessed in five different locations during rabi 2015-16 for genotype environment interaction (GEI) and stability for selection of the best hybrid(s). The AMMI (additive main effects and multiplicative interaction) model was used to analyze the genotype environment interaction over locations. Regarding genotypes (G), significant variation was found in all the characters except yield while environment (E) was found significant for all the characters. Considering the mean, bi and mean square deviation for all the parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. Among the tested hybrids; PCB12 × T17, PCB13 × T17 and PCB15 × T17 showed the higher yield, good popping quality and stable across the locations.

Comparative yield trial of imported and local maize hybrids

The experiment was composed of 14 hybrids, evaluated at six locations viz; Gazipur, Rangpur, Jamalpur, Barisal, Jessore and Hathazari following alpha lattice design with 3 replications during 2015-16 to select best stable hybrids among the imported and locally developed hybrids and it will be beneficial for the farmers.The environment of Gazipur, Hathazari, Jessore and Jamalpur were poor; but that of Rangpur and Barisal were ideal for hybrid maize production. Rangpur was found highly suitable for hybrid maize cultivation followed by Barisal. Considering the mean, bi and S^2di, all the hybrids showed different response of adaptability under different environmental conditions. Among the hybrids IM 8119 produced the highest yield (12.29 t/ha) followed by MZ04 (11.28 t/ha). Hybrids MZ04, 981, 9120, 9155, IM8119 and BHM 9 exhibited higher yield as well as stable over all environments.

F. Adaptive Trials

Adaptive trial with low water required white grain hybrid maize in High Barind Tract

A field experiment was conducted in the farmer's field of high barind tract OFRD site, Kadamshahar, Godagari, Rajshahi during Rabi season 2015-16 to test the performance of locally developed promising low water required hybrid maize and select short stature best one(s) for that area. Three hybrids viz. $P_1 \times P_4$, $P_1 \times P_7$, $P_2 \times P_5$ and Shuvra as check were evaluated in this study. After seedling establishment the hybrids were provided only one irrigation before flowering. Shuvra had both the shortest days to flowering (100 days) and maturity (135 days) but it had the highest plant height and ear height. Hybrids $P_1 \times P_4$ and $P_1 \times P_7$ produced the shortest plant and ear height. All the hybrids namely $P_1 \times P_4$, $P_1 \times P_7$ and $P_2 \times P_5$ gave non-significantly higher grain yield ranging from 8.50 to 8.95 tha^{-1}. The cross $P_2 \times P_5$ showed stay-green character at maturity. Variety Shuvra gave lowest yield (6.1 tha^{-1}) and had a lodging tendency.

G. Variety development of hilly areas

Evaluation of maize hybrids developed by using hilly germplasms in hilly areas

The present study revealed genotype-environment interaction (GEI) and stability for days to tasseling, days to silking, plant height, ear height, number of rows per ear, number of kernel per ear, 1000 seed weight and grain yield of fifteen single cross hybrids developed by using hilly germplasms including three checks across three different districts of Chittagong Hill tracts during 2015-16. Highly significant variations were observed for most of the characters such as days to tasseling, days to silking, ear length, 1000 seed weight, no. of kernels per ear and grain yield. Considering the mean, bi, Wricke's ecovalence and mean square deviation, five hybrids such as LG/S4-5-4×LG/S4-15-1(4.09 t/ha), P1×P7 (9.10 t/ha), LG/S4-9×LG/S4-2-1 (3.76 t/ha), LG/S4-14-6×LG/S4-14-3 (3.68 t/ha) and LG/S4-3-2×LG/S4-2-1 (3.65 t/ha) were found stable over locations. On the other hand, the hybrids P1×P4 (7.43 t/ha), BHM9 (6.47 t/ha) and LG/S4-15-2×LG/S4-15-1(3.32 t/ha) recorded as highly unstable.

Adaptive trial with low water required white grain hybrid maize in hilly areas

The experiment was carried out to determine the performance of six white grain maize hybrids for yield and other agronomic characters and stability that were grown across three environments viz. Khagrachari, Ramgharh and Hathazari during rabi 2015-16. All the genotypes showed significant differences for days to tasseling, days to silking, plant height, ear height, ear length, number of row per ear, 1000 seeds weight and yield across the environments except Hathazari, where only plant height, ear height and number of row per ear showed significant differences. Shuvra was the tallest (197cm) one and $P_1 \times P_2$ was the dwarf (164cm). Shuvra also bears the highest value (100cm) for ear height while $Q_1 \times Q_2$ had the lowest (73cm) ear height. The hybrid $P_2 \times P_5$ had bigger sized ear (18cm). Bold seeded entry was recorded in $Q_1 \times Q_2$ followed by $P_2 \times P_5$ where $P_1 \times P_2$ bears the smaller sized seeds. The hybrid $P_2 \times P_5$ showed better performance but it ranked 4 out of six genotypes for yield stability therefore, it is suited for favorable environment and the hybrid $P_1 \times P_2$ and $P_1 \times P_7$ the 2nd and 3rd yield scorer were also suited for favorable environments. None of the genotypes were stable over environments.

H. Maize biotechnology

Selection criteria, evaluation and associated genomic regions for multiple stress tolerance (salinity, water logged, low-p) in maize

A total of 29 commercial hybrid and 30 inbred lines were evaluated in saline (NaCl, 12 dSm^{-1}) and normal condition and 25 maize germplasm were also evaluated for seedling traits in hydroponic under low phosphorus LP (2.5×10^{-6} mol L^{-1} of KH_2PO_4) and normal phosphorus (NP) (2.5×10^{-4} mol L^{-1} of KH_2PO_4) conditions in a hydroponic culture at green house. Ten days old maize seedling was transplanted to hydroponic pot where they received salinity treatment for 18 days and the data were collected. Analysis of variance (ANOVA) showed significant of all genotype and highly significant of treatment for maximum root and shoot length, leaves area, shoot dry weight and total dry matter. All parameters under study of seedling decreased under salt treatment except chlorophyll content of some genotypes showed higher SPAD value than control. Cluster analysis placed the 29 hybrid into 5 main groups of which 3rd group showed the highest mean values for number of green leaves, maximum shoot length, leaves area, shoot dry weight and total dry matter. Based on the analysis, proline was the most tolerant hybrid after that 9120 (paloan), kaveri-25 and very susceptible genotypes were Heera, Raza and Kaveri-50.

In phosphorus evaluation, the first two principal components (PCs) explained about 91.13% of the total variation among lines for the eight maize seedling traits. The relative magnitudes of eigen vectors for the first principal component was 59.35%, explained mostly by total dry matter (TDM), shoot dry weight (SDW), root dry weight maximum root length (MRL) and MSL. The Euclidean genetic distance ranged from 0.61 to 29.33, indicating the high levels of variability among the inbred lines. The first three PCs explained more than 79% of total genetic variation. The G×T biplot revealed superior genotypes with combinations of favorable traits. Some outstanding genotypes with higher value of most RNS traits were identified. These lines could be of potential use for improvement of LP tolerance in maize.

P deficiency in plants trigger many transcriptional, biochemicals, and physiological changes that ultimately help the plants to absorb P from the soil or improve the P use efficiency. Substantial genetic variation in P efficiency exists among the maize genotypes and a number of QTLs controlling traits for P efficiency have been identified in maize, and it is expected that the integration of systems biology with high-throughput, high-dimensional and precision phenotyping will contribute to the development of maize varieties tolerant to LP stress.

Oxidative stress tolerance mechanism in maize seedlings under salinity stress

Susceptible genotypes of maize showed higher oxidative damage than tolerant one. Catalase (CAT) was not efficient in reducing H_2O_2 in maize under salinity. Non-enzymatic antioxidants like ASA and GSH and enzymatic antioxidant like peroxidase (POD), glutathione peroxidase (GPX) and monodehydroascorbate reductase (MDHAR) were important contributor to salinity tolerance. Proline and Glyoxalases partially contributed to the tolerance.

I. Stress Breeding: Abiotic stress tolerant variety development

Demonstration of selected HTMA hybrids at different agro ecological regions

Five HTMA hybrid maize selected under Heat Tolerant Maize for Asia (HTMA) project; one BARI developed hybrid BHM9; four imported hybrid maize viz. 981, NK-40, Pioneer 30V92 and Kaveri 50 used as checks, were evaluated in five locations viz., Gazipur, Rahmatpur, Jessore, Ishurdi and Burirhat to test the performance of the hybrids across environments in rabi season and to select the better performing one(s) having higher yield potentiality with desirable agronomic characters. Although none of the tested hybrids out yielded the best check variety 981 (10.67 t/ha) but two yellow grain hybrids, namely HTMA 19 (10.32 t/ha) and HTMA 22 (10.20 t/ha) and one white grain hybrid (HTMA 21) out yielded than rest four checks. Another white grain hybrid, HTMA 14 (9.93t/ha), was out yielded two checks viz. Pioneer 30V92 (9.91 t/ha) and Kaveri 50 (9.85 t/ha). Among the tested hybrids, only HTMA 14, was found moderately high yielder as well as lodging resistant. Considering overall mean grain yield and other desirable characters four hybrids viz. HTMA 14, HTMA 19, HTMA 21 and HTMA 22 were found most promising and hence could be selected for commercial cultivation across ecologies in Bangladesh.

Phenotyping of HTMA hybrids under optimal temperature at Rahmatpur (AS2BH 110, AS2BH 211, AS2BH 313, HTAMTC 72)

Fifty four crosses of field corn received under HTMA project along with six check hybrids 981, NK 40, Pioneer 30V92, 900 MG, BHM 7 and BHM 9 were evaluated at Regional Agricultural Research Station, Rahmatpur, Barisal during kharif 2015 to develop heat stress tolerant hybrids. The genotypes were evaluated in alpha lattice design replicated twice. Considering plant height, ear height, maturity and yield ZH15376 in trial AS2BH 110; ZH137991 in trial AS2BH 211; ZH141588, ZH138021 and ZH1311 in trial AS2BH 313 as well as ZH141212 in trial HTAMTC 72 were selected for further evaluation.

Phenotyping of HTMA hybrids under heat stress at Jessore (MPS3TC-212, MPS3TC-112, AS3BEHS-125 and AS3BMHS-125)

Six hundred ninety maize hybrids including three local check varieties received from CIMMYT, India under Heat Tolerant Maize for Asia (HTMA) Project were studied at the Regional Agricultural Research Station, Jessore during the kharif-1 season 2015. Significant variations were observed for most of the traits studied. Among the crosses considering yield and other contributing traits including heat stress tolerance the better hybrids were 159 (8.73 t ha^{-1}) and 98 (8.46 t ha^{-1}) in trial MPS3TC-212, ZH141590 (7.55 t ha^{-1}), ZH141591 (7.70 t ha^{-1}) and ZH141590 (7.57 t ha^{-1}) in trial ABS3BEHS-125 and ZH111948 (12.93 t ha^{-1}), ZH116108 (12.38 t ha^{-1}), ZH137890 (12.07 t ha^{-1}), VH11130 (11.99 t ha^{-1}) and ZH14399 (11.94 t ha^{-1}) in trial ABS3BMHS-125.

Phenotyping of HTMA hybrids under heat stress at Ishurdi (HTAMTC-14, HTAMTC-24, HTAMTC-34, HTAMTC-43, HTAMTC-53, HTAMTC-63, HTAMTC-73, HTAMTC-83, MPS4TC-110 and MPS4TC-210)

Performance of 1344 crosses received under HTMA project from CIMMYT, India including four local check varieties were studied at the Regional Agricultural Research Station, Ishurdi, Pabna during the kharif-1 season of 2015. High heritability was observed for days to pollen sheding, days to silking and kernel yield. Among the crosses considering yield and other traits including heat stress tolerance the better hybrids were Z543-82(8.34 t ha^{-1}) and Z543-79 (8.29 t ha^{-1}) in trial HTAMTC-14; Z543-376 (11.08 t ha^{-1}) and Z543-356 (11.0 t ha^{-1}) in trial HTAMTC-24; Z543-96 (8.59 t ha^{-1}) and Z543-10 (8.41 t ha^{-1}) in trial HTAMTC-43; Z574-68 (11.61 ha-1), Z574-64 (11.22 t ha-1), Z574-65 (10.89 t ha-1) and Z574-155 (10.84 t ha-1) in trial HTAMTC-63; Z574-78 (11.63 t ha^{-1}) , Z574-1 (10.01 t ha^{-1}), Z574-157 (9.73 t ha^{-1}) and Z574-70 (9.72 t ha^{-1}) in trial HTAM TC-73; Z574-183 (10.80 t ha-1), Z574-12 (9.98 t ha^{-1}), Z543-386 (9.92 t ha^{-1}), Z543-183 (9.88 t ha^{-1}) and Z543-38 (9.85 t ha^{-1}) in trial HTAMTC-83.

Adaptive trial of selected heat tolerant HTMA field corn hybrids in High Barind Tract

A field experiment was conducted in the farmer's field of OFRD site, Kadamshahar, Godagari, Rajshahi during *Rabi* season 2015-16 to find out the suitable variety of heat tolerant hybrid maize for obtaining higher yield and economic return in High Barind Tract. The experiment was laid out in a randomized complete block design with three replications. There were four hybrids viz. HTMA19, HTMA22, 981 and NK40 in the study. All the hybrids matured with the same duration. The plant height and ear height was the highest in 981 while NK40 produced the shortest plant and ear height. The highest grain yield was obtained from 981 (10.26 t ha^{-1}) and lowest in NK40 (8.45 t ha^{-1}), which HTMA19 and HTMA22 showed similar and intermediate yield performance which were 10.01 and 9.85 t ha^{-1}, respectively.

Multi location trial of the selected ATMA hybrids under optimal temperature

Combined analysis was carried out for grain yield, days to tassel, days to silk, plant height, ear height and 1000 grain wt. with sixteen selected ATMA hybrids and two checks across different locations. Analysis of variance for different characters showed the presence of genetic variabilities among the tested entries. From the overall mean yield and other desirable characters three entries viz. E_5, E_7 and E_{14} were found suitable across two locations.

J. CIMMYT program

Evaluation of CIMMYT acid soil tolerant tropical hybrid maize trial

Fifteen maize hybrids received from CIMMYT, Columbia to develop maize hybrids for tolerance to acidic soils with high aluminum toxicity were evaluated along with three checks NK40, BHM 7 and BHM 9 at the experimental fields of Regional Agricultural Research Station (RARS), Akbarpur and Hill Agricultural Research Station, Khagrachari during rabi, 2015-16. Considering overall mean performance of the two locations, the hybrid G15 yielded highest (9.92 t/ha) followed by G14 (9.83 t/ha) and G5 (9.76), whereas the best check G16 (NK40) produced overall mean yield 8.09 t/ha. Therefore, the hybrids G15, G14 and G5 were considered as stable yielder over the locations.

K. Nutritional maize breeding

Evaluation of quality protein maize (QPM) hybrids

Twenty four double and three way cross quality protein maize hybrids were evaluated along with two commercial checks (Pacific 60 and BARI hybrid maize 9) in an alpha lattice design with two replications. From the overall performance two hybrids [one double cross ($Q_6 \times P_2$) $\times P_4 \times P_6$) and one three way cross ($P_1 \times P_4$) $\times P_2$) were found promising and needs to verify them at different locations.

L. Production of New Hybrids

Production of single cross field corn hybrids following diallel fashion

Three sets of crosses following diallel fashion were made to produce hybrid seeds. Total 84 crosses were produced in three sets of diallel crosses. Among them, 78 crosses produced seeds. In set I; 14.61 kg seeds were obtained from 28 crosses. In set II; among 28 crosses, 22 crosses produced 3.79 kg seeds while in set III, 28 crosses produced 9.40 kg seeds. The produced F_1 seeds of each hybrid were stored separately after selection. The F_1's would be evaluated in the next rabi season in target areas.

Production of single cross maize hybrids following line × tester method

Seven sets (set I consists of 44 S_3 lines of PNL as lines and BIL 79 and BIL28 as testers where as set II consists of 37 S_3 lines of 981 as lines and BIL 79 and BIL28 as testers. Set III contains 40 non-QPM crosses produced by following 20 lines and 2 testers and set IV contains 40 QPM crosses produced by following 20 lines and 2 testers. Set V contains 64 crosses from 16 lines and 4 testers, Set VI contains 78 crosses from 39 lines and 2 testers and Set VII contains 42 crosses from 14 lines and 3 testers) of single cross maize hybrid seed was produced following line × tester method. Four hundred and twenty six crosses produced 93.68 kg seeds among which set I, set II, set III, set IV, set V, set VI and set VII produced 31.56 kg, 26.85 kg, 4.79 kg, 6.33 kg, 8.31 kg, 8.35 kg and 7.31 kg seeds, respectively. The F_1's will be used for evaluation in the next rabi season.

Production of single cross hybrids through north carolina design II fashion

One set of test cross was done following 7×7 North Carolina Design II. Total 49 crosses were made and 8.62 kg F_1 seeds were produced. These hybrids will be evaluated in the next rabi season to select promising one(s).

M. Maintenance and Seed Increase of Parent/Inbred Lines, Hybrids, Composite & OPVs

Maintenance and seed production of the parental lines of different hybrids

Total 3107 kg seeds were produced of the parents of different types of hybrids and stored for further use. Among them 4kg for maintenance, 177 kg from selfed bulked, 201 kg from parental lines of BARI developed hybrid, 590 kg for parental lines of low water required and 252 kg for HTMA hybrids.

Production of selected hybrids of promising crosses of saline, drought, excess moisture tolerant maize

In these experiments, hybrid seeds of promising crosses were produced to evaluate in next season. Total 137 crosses were made and from these crosses 170.52 kg seed was obtained. Moreover, 64 kg seed of male parent of BARI Hybrid Maize 13 was produced. These seeds will be used in evaluation or in hybrid production in next year trial.

Seed production of BARI maize hybrids

Hybrid seed is one the prime factors for increasing area and production in the country. Total 2031 kg hybrids seeds of 3 BARI maize hybrids viz. BARI hybrid maize 5, BARI hybrid maize 7, BARI hybrid maize 9 were produced at different locations in proper isolation condition maintaining female and male ratio of 4:2. At flowering stage, the plants from female rows were detasseled before pollen bursting and ears were collected from female plants, sorting, processed and stored for next year use and distribution.

Maintenance and seed production of BARI composite maize varieties

Total 2038 kg seeds of 6 composite varieties (Barnali, BM 6, BM 5, BM 7, Mohar, Khoibhutta and BARI Baby corn 1) were produced at different locations in proper isolation condition maintaining female and male ratio of 2:1. At flowering stage, male flowers (tassel) from female lines were detasseled and seeds were collected from the female plants and after sorting and processing stored them for next year use.

N. Technology transfer activities

During 2015-16, the Plant Breeding Division of BARI arranged one Training Program for 30 scientists and five field days for dissemination of technologies among farmers.

Barley, Millets & Sorghum

Hybridization of barley

The experiment was conducted at BARI, Gazipur during rabi season 2015-2016 to develop early, high yielding hull-less barley variety. Seven parental lines were crossed in a half diallel fashion. Among 21 crosses, 15 crosses produced seeds which will be used for confirmation trial in next year.

Evaluation and selection in different filial generation

Selected bulk method was followed during selection in different segregating generation. Selection was done based on earliness, short stature, hull-less and high yield. In F_2 generation, 9 plants from 2 crosses, in F_3 generation 17 plants from 2 crosses, in F_4 generation 6 families out of 6, in F_5 & F_6 generation 2 families out of 2 were selected.

Preliminary yield trial of barley

The experiment was conducted at BARI, Gazipur, during rabi season 2015-16 to evaluate 10 barley lines. Considering earliness, yield and yield contributing characters 4 barley lines were selected for next year trial.

Advanced yield trial of hull less barley

Combined analysis was carried out for grain yield, days to heading, days to maturity, plant height, tiller per plant, spike length, grains per spike and thousand grain weight with six lines including one check viz. BB-6 across 2 (two) different locations viz. Gazipur and Ishurdi, during rabi (2015-2016) to find out the suitable genotypes for next year yield trial. Analysis of variance for different characters showed the presence of genetic variabilities among lines. From the overall mean yield and other desirable characters two entries viz. E-2/15 and F_6 were found suitable across location.

Regional yield trial of hull less barley

Combined analysis was carried out for grain yield, days to heading, days to maturity, plant height, tiller per plant, spike length, grains per spike and thousand grain weight with five lines including one check viz. BB-6 across 2 (two) different locations viz. Gazipur and Ishurdi, during rabi (2015-2016) to find out the suitable genotypes for large plot yield trial. Analysis of variance for different characters showed the presence of genetic variabilities among lines. From the overall mean yield and other desirable characters two entries viz. BHL-21 and 6-B-952482 were found suitable across locations.

Observation trial of proso millet gerplasm

The experiment was conducted at BARI, Gazipur, during rabi season 2015-16 to select better performing proso millet germplasm. Considering earliness, yield and yield contributing characters 68 proso millet were selected from the 126 proso millet germplasm for next year trial. Among the genotypes, entry 5 and 6 ware registered for minimum days to maturity (96 days), the trait most desirable one. Entry 3 and entry 20 (2.41 t/ha) exhibited the highest yield followed by entry 4 (2.32 t/ha), entry 5 (2.27 t/ha) and entry 1 (2.13 t/ha).

International barley yield trial (IBON-HI)

Performance of 25 barley genotypes were investigated at the research field of plant breeding division of BARI, Gazipur, during rabi 2015-2016 to find out the suitable genotypes for large plot yield trial. The genotypes differed significantly for different traits except no. of tiller per plant and length of spike.

International barley observation nursery- high input conditions (IBON-HI)

The experiment was conducted at BARI, Gazipur, during rabi season 2015-16 to select better performing barley lines. Considering earliness, yield and yield contributing characters 13 lines were selected from the 139 barley lines for future breeding program.

International naked barley observation nursery (INBON)

The experiment was conducted at BARI, Gazipur, during rabi season 2015-16 to select better performing hull-less barley lines. Considering earliness, yield and yield contributing characters 5 lines were selected from the 75 barley lines for preliminary yield trial.

Breeder seed production of barley

To maintain the purity of the released barley varieties, total 348 kg of breeder seed of seven barley varieties viz. BARI Barley 1, BARI Barley 2, BARI Barley 3, BARI Barley 4, BARI Barley 5, BARI Barley 6 and BARI Barley 7 were produced in 4 different locations.

Breeder seed production of millets

Breeder seed is essential for maintaining purity of the variety. Total 142.5 kg breeder seed of Kaon and Cheena were produced at four locations.

Seed increase of selected foxtail millet, finger millet, pearl millet & sorghum germplasm

The experiment was conducted at BARI, Gazipur, during rabi season 2015-16 to increase seeds of selected different millets and sorghum germplasm. Total 5.7 kg seeds were produced from 8 selected Foxtail Millet germplasm and local check for next year trial. In addition a total of 26.1 kg seeds were produced from 10 selected finger millet germplasm, 2.5 kg seeds were produced from 9 selected pearl millet germplasm and total 4.5 kg seeds were produced from 5 selected sorghum germplasm for next yrar trials.

2 TUBER CROPS

Potato

Varietal Development

Hybridization in Potato

Potato is one of the most promising crops in Bangladesh due to its high productivity, short duration and wide adaptability. Potato research and development of HYV potato was started regularly in 1960, its varietal improvement has only been limited to introduction and selection until the year 2000 due to lack of initiatives. Potato plants do not flower under the short day conditions of Bangladesh. In the recent years, hybridization has been made possible at the TCRC after long lasting efforts on variety selection under extended photoperiod and use of flower induction techniques. Several treatments like extension of photoperiod, brick planting, stem girdling, grafting on tomato and use of hormones, alone or in combination, have been found effective in inducing flowers and berry setting in potato. Hybridization was done at Debigonj and Gazipur using 122 and 198 genotypes/varieties, respectively under 16 hours extended photoperiod to create variability, and for the selection of desirable genotypes. At Gazipur, 147 out of 331 crosses and at Debigonj, 388 out of 728 crosses produced berries. In total 305 g hybrid seeds were produced of which 105 g was at Gazipur and rest at Debigonj.

Production of seedling tubers of the potato hybrid (F_1C_0) population

Hybrid seeds which were produced in 2013-14 were sowed at Breeder Seed Production Centre, Debiganj on seedbed. Out of 826 crosses 192 were germinated and tubers of germinated crosses were harvested and stored for next year observation.

Selection of potato hybrids in subsequent clonal generations (F_1C_1, F_1C_2 and F_1C_3)

Clonal selection after hybridization is a continuous process of early generation. During the selection of hybrid seedling tubers of potato are subjected to further selection after field trials in each clonal generation. At the initial stage, clonal selection of potato is practiced only at BSPC, Debigonj due to favourable soil type and climatic condition. During selection planted potato clones are subjected to selection as single plant, plant row and single plot in subsequent clonal generations. In F1C1, F1C2 and F1C3 generations 51 potato clones weighing 1485 kg were selected and stored at BSPC, Debigonj for further evaluation.

Preliminary yield trial with clonal potato hybrids (F_1C_4)

Performance of 6 clonal hybrids and three check BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated at BSPC Debiganj, Panchagarh. Among the 9 genotypes, in case of marketable yield, the highest yielder (78.17t/ha) was clone 12.13 which was similar to clone 12.7 (75.98 t/ha) whereas the lowest yielder (44.58 t/ha) was check L. Rosetta. Thus the significantly highest amount of non-marketable tuber yield was performed by clone 12.28 and 12.20. Among the genotypes all clones gave more yield over check variety. Further study is required.

Secondary yield trial with F_1C_5 clonal hybrids of potato

Performance of 8 hybrid clones of potato was evaluated with check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25(Asterix) and BARI Alu-28(Lady-Rosetta) in Debiganj, Gazipur and Jamalpur. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of potato. Among the eight hybrid clones, clone 11.80 gave the significantly highest yield (37.79 t/ha) at 65 DAP which was statistically similar with 11.95 (36.78 t/ha) and 11.93 (36.44 t/ha). Clone 11.80, 11.93 and 11.95 can be selected for commercial cultivation due to its higher tuber yield potentiality as early bulker. Clone 11.95 gave the statistically highest yield (66.61 t/ha) at Debiganj. The significantly average highest yield (51.33 t/ha) was observed in clone 11.68 which was identical to clone 11.95 (50.84 t/ha) and 11.93 (49.26 t/ha) whereas the lowest tuber yield (21.31 t/ha) was with check Granola at Gazipur and lowest average yield (30.75 t/ha) was found in another check Lady Rosetta. Clone 11.68, 11.95 and 11.93 can be selected for commercial cultivation due to its higher tuber yield potentiality. Clone 11.77, 11.80 and 11.50 performed better than check regarding taste, appearance and texture of boiled potato. Finally clone 11.50, 11.68, 11.77, 11.80, 11.93 and 11.95 were selected for AYT on the basis of field performance and organolaptic taste.

Advanced yield trial of clonal hybrids of potato

Three clonal hybrids of potato were evaluated at six locations during 2015-16 for seventh generation. Data on marketable tuber yield at 65 DAP was recorded to identify the early bulker genotypes and this was the highest (43.01 t/ha) with clone 10.116 at Debigonj. And the same clone 10.116 performed the best average yield over the locations and it was 32.05 t/ha. On the other hand, Lady Rosetta and Diamant gave the lowest tuber yield (22.72 and 22.48 t/ha respectively) at 65 DAP. Clone 10.116 is the best performer as early bulker and, however. Clone 10.116 gave the highest yield (75.41 t/ha) at Jessore. Considering the average of six locations clone 10.116 also gave the significantly highest yield (48.98 t/ha), whereas the lowest tuber yield (31.48 t/ha) was with check Lady Rosetta and Asterix. Dry matter percentage at harvest was the highest with Lady Rosetta at Debigonj. Considering the average over locations, here check Lady Rosetta again gave the highest percentage of dry matter (21.37). Finally it can be said that Clone 10.116, 1058 can be selected as table potato for their higher yield potentiality and 10.116 were be selected as early bulker.

Participatory variety selection of advanced clonal hybrids

The selected three clonal hybrids with three checks varieties were evaluated at farmer’s field under participatory variety selection to understand the performance as well as farmers opinion. In case of average yield over six locations the highest tuber yield (38.88 t/ha) was recorded in 10.116 followed by 10.58 (35.78 t/ha) and lowest average yield was found in check varieties BARI Alu-28 (Lady Rosetta) (29.67 t/ha) and BARI Alu-25 (Asterix) (29.68 t/ha) (Table 1). Considering size, shape and colour, farmers of all locations showed their keen interest about all the clones.

Table 1. Performance of clonal hybrids of potato for tuber yield under PVS at 95 DAP in farmers’ fields

Variety/ Hybrid clone	Bog	Deb	Gaz	Jam	Jes	Mun	Mean
10.58	31.91	45.84	27.47	36.70	35.07	37.66	35.78
10.116	33.21	48.55	35.50	45.75	33.35	36.93	38.88
10.245	30.29	36.96	22.33	35.94	23.46	37.64	31.10
BARI Alu-7 (Diamant)	27.70	36.23	32.00	39.64	21.28	35.60	32.08
BARI Alu-25 (Asterix)	28.87	31.70	28.67	36.46	18.79	33.60	29.68
BARI Alu-28 (L. Rosetta)	32.33	35.83	18.67	35.57	19.17	36.44	29.67

Preliminary yield trial of exotic potato varieties in first generation for table and processing purposes

Potato variety development through hybridization and selection is common and popular in potato growing countries. As, it is a crop of cooler region, long day condition is required for flowering. But, in Bangladesh such condition does not prevail in all locations. So, variety development through hybridization and selection is a tedious job and takes more time. In that case to release a variety within a short period through introduction is skillful. Eight exotic potato genotypes namely Alouette, Carolus, Colomba, Fortus, Heraclea, Ivory Russet, Red Valentine, and Zina Redwith four check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25(Asterix), and BARI Alu-28 (Lady Rosetta) were evaluated at Gazipur, Munshigonj, Jessore, Bogra, Debigonj and Jamalpur during 2015-16. Combined analysis of variance showed highly significant difference between the genotypes, locations and GEI for all the characters studied. The highest tuber yield 59.49 t/ ha was recorded in Colomba at Debigonj. This genotypes also showed highest average yield (38.53 t/ha) all over the Bangladesh which was statistically different from all other genotypes. The genotypes Ivory Russet gave lowest tuber yield (7.20 t/ha) at Jessore. This genotypes also showed lowest average yield (20.95 t/ha) all over the locations of Bangladesh. All the exotic varieties showed satisfactory yield as first year trial, except Ivory Russet. Considering the overall yield and other characters all the genotypes were selected for further evaluation in the next year.

Secondary yield trial of exotic potato varieties for table and processing purpose

Thirteen exotic varieties along with four check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28 (L. Rosetta) were evaluated at six different agro ecological locations (Bogra, Debiganj, Gazipur, Jamalpur, Jessore and Munshigonj) during 2015-16 for second generation trial. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of potato. The genotype Farida gave the significantly highest yield (32.53 t/ha) at 65 DAP which was statistically identical with Cimega (32.05 t/ha). Farida and Cimega can be selected for commercial cultivation due to its higher tuber yield potentiality as early bulker. Exotic variety 7 four 7 gave the statistically highest yield (67.56 t/ha) at Debiganj. This variety also gave significantly average highest yield (45.81 t/ha) which was identical to Farida (44.42 t/ha), whereas the lowest average yield (31.81 t/ha) was found in check Lady Rosetta which was statistically similar with Canberra (31.96 t/ha) and another check variety Granola (32.14 t/ha). 7 four 7, Farida, Panamrra, Cimega, Memphis and Taisiya can be selected for commercial cultivation due to its higher tuber yield potentiality. Farida and Jelly performed better than check regarding taste, appearance and texture of boiled potato. Finally Exotic variety Farida, Cimega, 7 four 7, Panamrra, Memphis, Taisiya and Jelly were selected for AYT on the basis of field performance and organolaptic taste.

Advanced yield trial with exotic potato varieties for table and processing purpose

Three exotic varieties were evaluated at six locations during 2015-16 for third generation. Marketable tuber yield at 65 DAP was recorded to identify the early bulker genotypes and this was the highest (39.48 and 39.35 t/ha) with Yukon Gem at Debigonj and Jamalpur. The same variety performed the best average yield over the locations and it was 28.60 t/ha. On the other hand, check Asterix gave the lowest marketable tuber yield (21.13 t/ha) at 65 DAP. However, almost all the tested varietis performed about 25 t/ha over the Bangladesh. Camel and Yukon Gem gave the statistically highest yield (60.68 and 59.68 t/ha accordingly) at Debigonj during harvesting at 95 DAP. Considering the average of six locations Camel also gave the significantly highest yield (42.28 t/ha), whereas the lowest tuber yield (30.59 t/ha) was with check BARI Alu-25 (Asterix). Dry matter percentage at 95 DAP was the highest (23.53 t/ha) with Verdi at Bogra. Considering the average over locations, here Verdi again gave the highest percentage of dry matter (22.16). On the basis of advanced yield trial

Yukon Gem and Camel were selected for RYT as table potato due to their higher yield potentiality, on the other hand Verdi need to be close observation for processing purposes due its high capable of dry matter.

Participatory variety selection of advanced exotic potato varieties for table, export and processing purposes

Three exotic potato varieties namely Camel, Verdi and Yukon Gem selected from last three consecutive years along with check varieties BARI Alu-7 (Diamant) and BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated in farmer's field of six different locations. The average highest tuber yield (33.99 t/ha) was recorded in Camel followed by Verdi (32.09 t/ha) and lowest average yield was found in check variety BARI Alu-28 (Lady Rosetta) (28.81 t/ha) (Table 1). Considering size, shape and colour, farmers of all locations showed their keen interest about all the exotic varieties.

Table 1. Performance of exotic potato varieties for tuber yield under PVS at 95 DAP in farmers field

Variety/ Location	Bog	Deb	Gaz	Jam	Jes	Mun	Mean
Camel	30.70	50.58	28.00	35.97	22.01	36.69	33.99
Verdi	23.39	36.96	33.33	34.24	27.70	36.93	32.09
Yukon Gem	29.88	32.56	32.67	37.02	21.16	34.14	31.24
BARI Alu-7 (Diamant)	26.60	36.23	32.00	39.64	21.28	33.60	31.56
BARI Alu-25 (Asterix)	29.98	31.70	28.67	36.46	18.79	30.96	29.43
BARIAlu-28 (L.Rosetta)	27.18	35.83	18.67	35.57	19.17	36.44	28.81

Regional yield trial with exotic potato varieties

Three exotic table potato varieties as Set-I namely Bercelona, Montecarlo and YP-04-80 along with check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola) and two exotic processing potato varieties as Set-II namely Caruso and Tomensa along with check varieties BARI Alu-28 (Lady Rosetta) were evaluated at six different agro ecological environments/locations during 2015-16 cropping season in RYT. Combined analysis was done to observe the genotype location interaction. Expression of different characters of potato was influenced by different environment factors. All the tested exotic varieties in Set-I yielded higher than the all check varieties in both 65 and 95 DAP but in Set-II Caruso yielded higher and Tomensa yielded lower than check variety both at 65 DAP and 95 DAP (Table 1). Satisfactory dry matter percent was also in all tested exotic varieties in Set-I as tablepotato. Especially Montecarlo identified as short duration variety. Parameter of commercial processing indicated that all the tested exotic varieties in Set-II as processing potato are suitable for processing. So, considering the yield in farmers' field trial, post-harvest, own processing, disease and insect data exotic variety Bercelona, Montecarlo and YP-04-80, and Caruso and Tomensa were advance for release as table and processing commercial varieties respectively.

Table 1. Tuber yield of exotic potato varieties for tuber yield at six locations at 95 DAP

Variety/ Genotype	Tuber yield (t/ha) at 95 DAP						
	Bog	Deb	Gaz	Jam	Jes	Mun	Mean
Set-I							
Bercelona	38.93 c-g	67.51 a	37.38 d-h	46.89 bcd	42.73 cde	46.23 bcd	46.61a
Montecarlo	41.00 c-f	53.23 b	32.23 f-i	35.92e-h	23.62 ij	37.50 d-h	37.25 b
YP-04-80	37.48 d-h	56.03 b	25.82 ij	38.58 c-g	32.44 f-i	54.16 b	40.75b
BARI Alu-7 (Diamant)	31.11 f-j	37.47 d-h	25.09 ij	31.57 fg-j	25.04 ij	39.84 c-g	31.69 c
BARI Alu-13 (Granola)	27.80 hij	47.80 bc	21.70 j	30.87g-j	22.06 j	37.62 d-h	31.30 c

Variety/ Genotype	Tuber yield (t/ha) at 95 DAP						
	Bog	Deb	Gaz	Jam	Jes	Mun	Mean
Set-II							
Caruso	32.08 de	40.37 bc	30.48 def	40.85 bc	27.74 efg	44.40 ab	35.99 a
Tomensa	19.70 i	35.60 cd	18.06 i	27.53 efg	21.67 hi	28.58 efg	25.19 c
BARI Alu-28 (L. Rosetta)	28.55 efg	47.20 a	23.54 ghi	30.73 def	25.66 fgh	38.58 c	32.38 b

Participatory variety selection of exotic potato varieties

Three exotic potato varieties as Set-I namely Bercelona, Montecarlo and YP-04-80 selected for table potato from last three consecutive years along with check varieties BARI Alu-7 (Diamant) and BARI Alu-13 (Granola) and two exotic potato varieties as Set-II namely Caruso and Tomensa selected for processing potato from last three consecutive years along with check varieties BARI Alu-28 (Lady Rosetta) were evaluated in farmer's field of six different locations. In case of set-I average yield over six locations the highest yield (39.77 t/ha) was produced by the variety Bercelona followed by YP-04-80 (37.51 t/ha) and Montecarlo (34.74 t/ha) and the lowest yield 31.84 t/ha recorded in the variety BARI Alu-13 (Granola) (Table 1). In case of set-II yield over six locations the highest yield (33.45 t/ha) was produced by the variety Caruso followed by BARI Alu-28 (Lady Rosetta) (31.12 t/ha) and the lowest yield 28.65 t/ha recorded in the exotic variety Tomensa. Considering yield size, shape and colour, farmers of all locations showed their keen interest about the all exotic verities but varied over locations.

Table 1. Performance of exotic potato varieties for tuber yield under PVS at 95 DAP in farmers field

Variety/ Location	Bog	Deb	Gaz	Jam	Jes	Mun	Mean
Set-I							
Bercelona	49.01	62.66	31.33	29.00	32.06	34.56	39.77
Montecarlo	51.76	42.52	24.00	32.05	31.26	26.83	34.74
YP-04-80	34.24	56.32	28.33	34.25	37.92	34.00	37.51
BARI Alu-7 (Diamant)	30.97	36.23	32.00	39.64	21.28	43.51	33.94
BARI Alu-13 (Granola)	32.67	46.80	31.33	34.24	19.72	26.30	31.84
Set-II							
Caruso	31.59	50.28	29.00	35.57	25.43	28.85	33.45
Tomensa	27.32	29.55	31.33	37.62	17.47	28.62	28.65
BARI Alu-28 (L.Rosetta)	31.29	49.28	18.67	35.50	19.17	32.78	31.12

Regional yield trial for late blight tolerant exotic potato variety

The experiment was conducted with one late blight tolerant promising exotic variety Sarpo Mira and two ckeck varieties BARI Alu-7 (Diamant) and BARI Alu-46 at RARS, Burirhat, Rangpur; TCRSC, Bogra and RARS, Jamalpur during 2015-16. At 65 and 95 DAP, the highest mean yield was obtained from the proposed variety Sarpo Mira (27.71 t/ha and 33.40 t/ha) while the lowest yield was obtained from the variety BARI Alu-7 (18.20 t/ha and 20.28 t/ha) (Table 1). The lowest mean late blight infection (1.99%) was recorded in Sarpo Mira and the highest was in BARI Alu-7 (93.30 %) (Table 2). Shape, colour, depth of eye and flesh colour of the proposed variety Sarpo Mira was good as per consumer preference.

Table 1. Performance lateblight resistant exotic potato variety on tuber yield under RYT during 2015-16

Variety/Genotype	Tuber yield (t/ha) at 95 DAP			
	Bogra	Jamalpur	Rangpur	Mean
Sarpo Mira	27.95 a	42.47 a	29.77 b	33.40
BARI Alu-46 (LB-7)	26.91 ab	28.60 b	37.07 a	30.86
BARI Alu-7 (Diamant)	19.52 c	25.94 b	15.37 c	20.28

Table 2. Performance late blight resistant exotic potato variety on disease incidence and cutworm infestation under RYT during, 2015-16

Variety/Genotype	Late blight infection (%)			
	Bogra (80 DAP)	Jamalpur (65 DAP)	Rangpur (70 DAP)	Mean
Sarpo Mira	0.96	2.00	3.00	1.99
BARI Alu-46 (LB-7)	1.263	3.50	3.00	2.59
BARI Alu-7 (Diamant)	99.10	80.00	100.00	93.30
Variety/Genotype	Lateblight infection (%)			
	Bogra (88 DAP)	Jamalpur (95 DAP)	Rangpur (92 DAP)	Mean
Sarpo Mira	2.2	65.00	75.00	47.4
BARI Alu-46 (LB-7)	4.4	60.00	80.00	78.13
BARI Alu-7 (Diamant)	100	90.00	100.00	96.67

Participatory variety selection for late blight tolerant exotic potato variety

One exotic varieties viz. Sarpo Mira with checks BARI Alu-46 (LB-7) and positive check BARI Alu-7 (Diamant) were evaluated in farmer's field of three different locations. In case of average yield over three locations the highest yield (39.28 t/ha) was produced by the variety BARI Alu-46 (LB-7) followed by Sarpo Mira (37.91 t/ha) and the lowest yield 22.41 t/ha recorded in the variety BARI Alu-7 (Diamant) (Table 1). Considering size, shape and colour, farmers of all locations showed their keen interest about the exotic variety Sarpo Mira.

Table 1. Performance of exotic potato varieties for tuber yield under PVS at 95 DAP in farmers' field

Variety/ Location	Bogra	Jamalpur	Rangpur	Mean
Sarpo Mira	56.69	28.53	28.52	37.91
BARI Alu-7 (Diamant)	26.67	28.35	12.21	22.41
BARI Alu-46 (LB-7)	43.63	40.32	33.88	39.28

Observation trial with clonal hybrids and exotic varieties for early heat tolerant

Farmers in the northern part of Bangladesh cultivate potato using BARI released varieties which are not suitable for that climatic condition. Therefore, they do not get optimum yield and sufficient economic benefit. Another point is that farmers of northern part of Bangladesh cultivate potato two times within the season. Although our released varieties are not suited perfectly in that region but they still cultivate by gaping one crop production to make up cropping pattern. Under this circumstances, early planting variety (early heat tolerant) development is an essential task. Therefore, development of early and heat tolerant variety and short duration (80 Days) were the objectives of this experiment. Heat tolerant yield trial was conducted at BSPC, Debigonj during rabi season 2015-2016. Seven clonal hybrids develop from own crossing program, 15 exotic varieties and two checks, BARI Alu-13 (Granola) and BARI Alu-41 (5.183), were tested. Vardi gave higher number of tuber/hill but gave the lowest tuber yield/hill that means Vardi was very sensitive to high temperature stress. Marketable tuber yield means the tuber which is suitable for common market. Here, non-marketable tuber defined as very under size tuber, cracked tuber, diseased tuber and insect infested tuber. The highest marketable tuber yield was found in Coronada (66.85 t/ha) which succumbed to 1.24 t/ha non-marketable tuber of which 46.92% cracked tubers. The lowest marketable tuber yield was found in Vardi. Checks BARI Alu0-13 (Granola) and BARI Alu-41 (5.183) gave 45.21 t/ha and 46.80 t/ha marketable tuber yield respectively. Coronada (66.85 t/ha), Camel (54.27 t/ha), Clone 12.22 (52.03 t/ha), Taisiya (50.86 t/ha), Granada (50.31 t/ha), Panamrra (49.26 t/ha), Clone 12.27 (49.04 t/ha), Clone 12.7 (49.04 t/ha), 7 four 7 (48.29 t/ha), Memphis (47.32 t/ha) and Farida (47.06 t/ha) showed better performance than both the checks while Clone 12.13 (46.41 t/ha) and Clone 12.28 (46.39 t/ha) performed better than check Granola. These 13 genotypes need to be further studied.

Selection of heat tolerant potato variety for early planting

Observational yield trial against high temperature stress was conducted at BSPC, Debigonj during rabi season 2015-2016. Twenty-two varieties which already approved for local cultivation and two checks, BARI Alu-13 (Granola) and BARI Alu-41 (5.183) were tested. Marketable tuber yield means the tuber which is suitable for common market. Here, non-marketable tuber defined as very under size tuber, cracked tuber, diseased tuber and insect infested tuber. The highest marketable tuber yield was found in BARI Alu-54 (Musica) (56.31 t/ha) which succumbed to 5.59 t/ha non-marketable tuber of which 68.64% cracked tubers. The lowest marketable tuber yield was found in BARI Alu-43 (Atlas) but it performed the highest amount of non-marketable tuber (15.50 t/ha). Checks BARI Alu-13 (Granola) and BARI Alu-41 (5.183) gave 34.94 t/ha and 49.42 t/ha marketable tuber yield respectively. BARI Alu-54 (Musica) (56.32 t/ha), BARI Alu-51 (Bellarossa) (51.12 t/ha) and BARI Alu-42 (Agila) (49.59 t/ha) performed better than both the checks. BARI Alu-58 (El Mundo) (49.13 t/ha), BARI Alu-46 (LB-7) (48.71 t/ha), BARI Alu-45 (Steffi) (48.06 t/ha), BARI Alu-44 (Elgar) (46.93 t/ha), BARI Alu-55 (Red Fantasy) (45.52 t/ha), BARI Alu-60 (Vivaldi) (44.96 t/ha), BARI Alu-48 (7.33) (43.38 t/ha), BARI Alu-52 (Labadia) (42.27 t/ha), BARI Alu-56 (8.46) (41.57 t/ha), BARI Alu-59 (Metro) (41.31 t/ha), BARI Alu-49 (7.58) (41.12 t/ha), BARI Alu-47 (7.12) (41.01 t/ha), BARI Alu-40 (4.45W) (40.77 t/ha), BARI Alu-57 (8.73) (40.46 t/ha), BARI Alu-50 (7.86) (38.80 t/ha) and BARI Alu-53 (LB-6) (36.09 t/ha) performed better than heck BARI Alu-13 (Granola) (34.94 t/ha) only.These 19 genotypes need to be further studied.

Observational trial with CIP potato clones for heat tolerance

Fourteen CIP bred potato clones with two check variety Asterix and Granola were assed for heat tolerance following split plot design with randomized complete blocks (RCB) arrangements replicated thrice in the experimental field of Tuber Crops Research Sub-Centre, Bogra, in non-stress (Standard/non-stress planting on 20 Nov. 2015) and heat stress (Late planting on 20 Dec. 2015) conditions during 2015-16 cropping season. In heat stress condition, mean plant height increased by 34.61% and it was common in all potato genotypes. Other yield contributing characters like stem per hill, canopy coverage (%), plant vigor and tuber number per plant were increased under heat stress condition. However, yield (t/ha) at 70 and 90 DAP were decreased by 9.74 % and 21.29%, respectively under heat stress condition. CIP-203 (40.66 t/ha) was the highest yielder followed by CIP-118 (38.48 t/ha), CIP-218 (38.12 t/ha), CIP-127 (35.15 t/ha), LB-7 (34.24 t/ha), CIP-202 (33.38 t/ha) and CIP-220 (33.25 t/ha) under non-stress and while under heat stress condition CIP-218 (32.89 t/ha) was the highest yielder followed by CIP-118 (32.22 t/ha), CIP-203 (29.95 t/ha), LB-7 (28.56 t/ha), CIP-127 (26.92 t/ha), CIP-235 (26.90 t/ha, CIP-221 (26.74 t/ha) and CIP-112 (26.43 t/ha). CIP-118, CIP-127, CIP-203, CIP-218 and LB-7 were the good yielder in both growing conditions. To select the potato genotypes more preciously for heat stress (late plantation), several indices were applied and ranked the genotypes accordingly. According to rank sum, among the sixteen potato genotypes, CIP-218, LB-7, CIP-118, CIP-235 and CIP-112 were selected as heat tolerant potato and had the ability to grow in both growing conditions with higher yield potential.

Participatory variety selection through secondary yield trial (SYT) of CIP potato clones for tolerance to salinity

Salinity is one of the most important environmental stresses which severely limit plant growth and productivity worldwide and the problem is ever increasing. In Bangladesh, more than 1 million hectares of the coastal areas have been seriously affected by salinity which is considered as one of the major problems of crop production. The development of potato genotypes that are more tolerant to salinity stress is a practical and economical approach to lessen the negative effects of salinity stress on the productivity of the crop. However, in order to develop salinity stress tolerant potato varieties in Bangladesh this study was planned and undertaken for assessing the genotypes against salinity stress condition in collaboration with the International Potato Center (CIP) and Tuber Crops Research Centre (TCRC) of BARI. Four CIP potato clones namely, CIP-112 (380606.6), CIP-117 (386292.3), CIP-120 (389429.31) and CIP-124 (392781.1)along with 2 check varieties Diamant and Asterix were evaluated at three saline areas OFRD, Noakhali, Kuakata, Patuakhali & ARS, Satkhira during 2015-16 cropping season for their suitability to salt tolerance. It was observed that tuber yield and other yield contributing characters like; days to start emergence, plant height, stem per hill, plant vigor, foliage coverage, and plant senescence at 67 to 81 days after planting and yield (t/ha) were varied significantly among the tested clones/varieties across the locations. At planting, in the mother trial, the highest salinity level was recorded at ARS, Satkhira (3.38 dS/m) and the lowest was at OFRD, Noakhali (1.58 dS/m). During harvesting time, the highest salinity level was recorded at Kuakata, Patuakhali (13.48 dS/m) and it was lowest at OFRD, Noakhali (5.34 dS/m). But in the farmer's trial field, it was ranged from 4.21 to 15.41 dS/m. Mean highest yield was observed in CIP 112 (21.36 t/ha) followed by Diamant (20.03 t/ha). Based on tuber yield and senescence percent at three locations, CIP-112 and CIP 124 showed best performance in saline condition. Finally, these 2 CIP clones, viz. CIP-112(380606.6) and CIP-124 (392781.1) were found promising for their good yield, shape and size, color of skin, texture, and storability on ambient temperature and could be recommended to include in the advanced yield trial in the next cropping season.

Advanced yield trial (AYT) of virus resistant CIP potato clones

The seed potato infected with PVY and PLRV seems to be degenerated in the successive generation. This is also an acute problem of seed potato production in Bangladesh and in case of severity, the diseases can reduce tuber yield by up to 78% and 85%, respectively. The possibility to ensure the high yield of potato remains to a great extent with management of viruses and it is very easy to overcome the problem with variety tolerant to viruses with high yield potential. Considering these facts, the present experimental trial has jointly been undertaken by the CIP and TCRC to evaluate the performance of CIP potato clones' tolerance to virus diseases. An advance varietal selection trial was conducted with 2 CIP virus resistant potato clones against 2 check varieties Diamant and Asterix at 6 locations of Bangladesh during 2015-16 crop season for their suitability and yield potentiality. Except Asterix, more than 90% mean emergence was recorded at 30 days after planting in all tested clones. Vigorous growth was recorded in all CIP clones in all locations. Other morphological characters like, canopy coverage and stem per hill showed significant variation among the clones across the locations. Yield (t/ha) were varied significantly in all locations and ranged from 21.37-50.27 t/ha. The mean highest yield was recorded in CIP- 10 (43.97 t/ha) and the lowest was in the check variety Asterix (29.61 t/ha). Considering the yield performance over the locations, shape, size, colour, disease reactions and ambient storage behaviour 2 CIP clones namely, CIP-10 (CIP 397029.21) and CIP-13 (CIP 397073.7) were be selected for regional yield trial (RYT) in next cropping season.

Participatory variety selection through regional yield trial of CIP promising potato clones

A regional participatory varietal selection trial was conducted with 2 CIP promising potato clones with 2 check varieties Diamant and Asterix at 6 locations of Bangladesh during 2015-16 crop season for their suitability, yield potentiality, taste and storability. CIP clones; CIP-112 and CIP-126 showed more than 95% emergence at 30 days after planting at all locations. Yield contributing characters like plant height, plant vigor, canopy coverage and stem per hill were varied significantly. Tuber yield varied significantly at 65 and 95 DAP harvest in all locations among the clones/varieties. Taller plant with vigorous growth was found in 2 CIP promising clones. At 65 DAP tuber yield among the clones in all locations were ranged from 16.64-34.91 t/ha; where CIP-126 (31.48 t/ha) was the mean highest yielder and CIP-112 (28.24 t/ha) was the 2nd highest yielder. At 95 DAP, yield was ranged from 16.70 to 62.44 t/ha; CIP 112 (44.20 t/ha) was the mean highest yielder and CIP-126 (40.62 t/ha) was the mean 2nd highest yielder. Regarding pest and diseases minimum/lowest infections were found in CIP clones. Through participatory variety selection, based on tuber yield, shape, size, color, taste and storage behavior 2 CIP clones namely, CIP-112 (380606.6) and CIP-126 (392797.22) could be recommended to release as variety for commercial cultivation in Bangladesh.

Participatory variety selection of CIP potato clones through mother & baby trial approach for processing qualities

Ten CIP advance potato clones with three improved potato varieties, Diamant, Asterix and Lady Rosetta were included in the Participatory Mother and Baby trial during 2015-16 for growth, yield and postharvest processing quality study at three locations namely; RARS, Jessore, RARS, Barisal and TCRSC, Bogra. In the trial, at Barisal and Jessore research stations and farmers' fields, the crop was evaluated at three stages namely, vegetative, harvesting and at post-harvest stage. Results showed that at vegetative stage, according to global score CIP-213 ranked 1st followed by CIP-232, CIP-225, CIP-224 and CIP-231. Considering global score at harvesting stage, CIP-218 performed as best followed by CIP-213, CIP-225, CIP-239 and CIP-235. The mean highest yield from mother trial was found in CIP-225 followed by CIP-224, CIP-239, CIP-218 and CIP-213. However, in the baby trials, CIP-218 was the mean the highest yielder followed by CIP-239, CIP-235, CIP-229 and CIP-232. Considering the mean of mother and baby trials in all locations, CIP-218 (34.19 t/ha) was ranked 1st, CIP-239 (34.13 t/ha) ranked 2nd, CIP-225 (34.08 t/ha) ranked 3rd position. CIP-224 (31.99 t/ha) and CIP-235 (29.85 t/ha) were in the 4th and 5th position, respectively. Through organoleptic evaluation on appearance, texture and taste at Barisal &Jessore locations, CIP-229, CIP-239, CIP-235, CIP-224 and CIP-223 were found promising. After 90 days of storage in ambient condition, CIP-213, CIP-223, CIP-224, CIP-225, CIP-235 and CIP-239 showed best performance regarding weight loss. In case of rotted tuber number, the mean lowest (1.66%) was found in CIP-235. Minimum sprouting (1.25%) was also found in CIP-235 up to 90 days after harvesting.

Morphological characterization and photo-graphic documentation of AYT materials

Precise information about the extent of genetic divergence and on characters used for discrimination among the population is crucial in any crop improvement program, because selection of plants based on genetic divergence has become successful in several crops. In recent years a number of newly developed advanced breeding lines have been added to the germplasm collection. Therefore, the parents to be used in breeding improved potato cultivars to grow in these contrasting growing conditions ought to be different. No information regarding the extent of genetic divergence in these newly acquired potato lines, is available under this condition. In view of the above, the present study has been undertaken to collect information on genetic divergence in the newly acquired genotypes so that useful parental materials for the breeding program could be selected. Thirteen advanced lines of potato derived from own hybridization program of TCRC were characterized at Breeder Seed Production Centre, Debigonj during winter season in 2012-13 and 2013-14. The collection exhibited low variation for the qualitative characters as reflected by mean diversity index of 0.34. Medium degree of variation exhibited within the collection for the quantitative characters, as reflected by mean diversity value of 0.67. Pooling of diversity values for the qualitative and quantitative characters traits gave an overall diversity index of 0.51, indicative of medium variability existing within the collection.The genotypes were grouped into four different clusters. Cluster I had the maximum of six genotypes while cluster II and IV had only one genotype. The highest inter-cluster distance was observed between cluster II and III and the lowest inter-cluster distance was observed between cluster III and IV. The highest intra cluster distance was found in cluster I, whereas Cluster II (0.00) and cluster IV (0.00) showed zero intra cluster distance due to containing only one genotype. The highest inter-genotype distance was observed between genotypes 8.46 and 7.33 (33.79) and the lowest distance was observed between genotypes 7.86 and 7.48 (5.70). Results of PCA showed reduction of the sixteen original variables to three independent linear combination of principal component of variables. Number of tuber/hill made contribution the maximum towards divergence.

Morphological characterization and photographic documentation of advanced CIP potato clones

Morphological characterization is essential for recognizing, distinguishing and describing a variety. The central theme is identification of a variety through the use of some parameters of characterization. Precise information about the extent of genetic divergence and on characters used for discrimination among the population is crucial in any crop improvement program, because selection of plants based on genetic divergence has become successful in several crops. In recent years a number of newly developed advanced breeding lines have been added to the germplasm collection. Therefore, the parents to be used in breeding improved potato cultivars to grow in these contrasting growing conditions ought to be different. No information regarding the extent of genetic divergence in these newly acquired potato lines, is available under this condition. In view of the above,the present study has been undertaken to collect information on genetic divergence in the newly acquired genotypes so that useful parental materials for the breeding program could be selected. Ten CIP advanced clones were characterized at BSPC, Debigonj Bangladesh during winter in 2015-16 following the DUS (Distinctness, Uniformity and Stability) descriptor which is approved by the National Seed Board of Bangladesh and descriptor of CIP, Peru. Large variation was found among the genotypes and distinct characters were recorded which could be help to find out the respective clones as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Morphological characterization of advanced breeding lines and BARI released potato varieties

Eight advanced clones of potato developed from own crossiong program of TCRC and sixteen exotic varieties were characterized at BSPC, Debigonj, Bangladesh during winter in 2015-16 following the DUS (Distinctness, Uniformity and Stability) descriptor which is approved by the National Seed Board of Bangladesh and descriptor of CIP, Peru. Large variation was found among the genotypes and distinct characters were recorded which could be help to find out the respective clones as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Maintenance of released potato varieties, germplasm, lines and TPS parents

Any variety, line, genotypes and land races considerd as germplasm which are very important for breeding point of view. Number of germplasm is also important for genetic base of the population. If the number is high the genetic base is high and contained high genetic pool. Some of the materials contained some valuable genes which are important for future breeding work. In that case Maintenance breeding is very much important for conservation as well as preservation of gene pool in future use. It is also necessary for breeding programme in our country, where the variability of potato is very low because potato is not a crop in this region. Maintenance breeding is the routine work of TCRC for future use of valuable materials. Potato needs to grow every year and stored in cold storage in our climatic conditions. Each and every year all the germplasm grown under net house in BSPC, BARI, Debigonj and after harvest stored in cold storage. A total of 1115 kg seeds of potato were preserved in Breeder Seed Production Center cold store, Debiganj, Panchagarh collected from 223 potato variety/germplasm/hybrid clone during 2015-16.The preserved materials will be used in future for variety development programme.

Multiplication, purification and maintenance of indigenous potato varieties

Indigenous potato variety (IPV) contents higher proportion of amylopectin than EPV which make them sticky and testier. In spite of low yields, the IPV are popular among the growers and consumers mainly for containing higher percentage of dry matter and as such exhibit good keeping quality under ordinary temperature. Besides, IPV gives reasonable yield under low input condition and because of that, it fits well into the production system of small and marginal farmers. Due to farmers and consumers acceptability particular attention should be given to the maintenance and improvement of IPV. That's why these materials should be maintained and purified through clonal selection over the year. After purification each year yield performance should also checked with view to how much progress of yield compared to previous year. These were the objectives for this trial. Nine (9) cultivers namely Ausha, Challisha, Dohazari, Indurkani, Lalpakuri, Patnai, Shilbilati, Sindurkauta and Sadaguti planted during 2015-2016. Off type and disease infested plants were roughed out from each plot. 82.00 kg Clean Seeds of nine cultivars along with 74 kg from 34 selected clonal have been stored at BSPC, BARI, Debiganj, Panchagarh cold storage for next year trial and maintenance purposes.

Biotechnology and Seed Production

Production, distribution and *in vitro* maintenance of potato varieties/germplasm

In vitro plantlets production, conservation and maintenance of tuber crops varieties/genotypes at Tissue Culture Lab of TCRC, BARI is a continuous process. This program is necessary for maintenance breeding and breeder seed production of BARI recommended varieties and CIP genotypes. *In vitro* plantlets of potato were produced from virus free potato tubers of different potato varieties and genotypes using MS media under aseptic conditions during 2015-16. Several subcultures were done using node cuttings for plantlet production and short term conservation. A total of 1310 and 2200 disease free plantlets of BARI released potato varieties and CIP genotypes, respectively were sent to Breeder Seed Production Centre, Debigonj for G_1 generation development. Moreover, 28.5 kg virus free minitubers of BARI released varieties and 302.0 kg breeder seed of CIP genotypes were sent to BSPC, Debigonj for multiplication. A total of 35 CIP clones having 581disease free plantlet and 21 BARI released potato varieties having 620 disease free plantlets have been maintained at Tissue Culture of TCRC, BARI as mother stock.

Production of minituber (G_0) from *in vitro* plantlets at net house conditions

Large scale minituber production of potato is important for breeder seed production. Plantlets of BARI released potato varieties and CIP genotypes are used for quality minituber production every year. Minituber was produced from virus free *in vitro* plantlets of potato at net house of TCRC, BARI during 2015-16. Number of minituber per plant 18.5, 14.75, 26.5, 22.0, 19.8, 23.8 and 25.25 were recorded from the varieties BARI Alu-8, BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-41, BARI Alu-46, BARI Alu-53, respectively where the average number of minituber per plant was 21.57. The maximum weight of minituber per plant was found from the variety BARI Alu-46 (159.0 g) followed by BARI Alu-41 (129.6 g), BARI Alu -37 (126 g), BARI Alu -8 (103.75 g), BARI Alu -35 (101.4 g) and BARI Alu 25 (88.25 g), respectively.

Production of breeders and foundation potato seed at BSPC, debiganj, panchagarh in 2015-2016

During 2015-16, 155 acres of land were used for seed potato production. where 80.0 acres were under nucleus seed (mini tuber) and breeder seed production programme. Rest of the area was covered with foundation seed , true potato seed (TPS), tuberlet production and research activities . A total of 951.34 tons seed potato was produced at BSPC, Debiganj during 2015-16. Among the different types of seed nucleus seed, minituber, breeder seed, first generation (G_1) seed, second generation (G_2) seed, nucleus seed (minituber) of CIP clones. foundation seed, experimental materials (Germplasm) were 4658, 269.84, 57.19, 57.07, 31.65, 499.85 and 35.00 tons were potato seeds were harvested, respectively during 2015-16. Moreover, a total of 0.350 kg TPS has been produced from different lines of potato. In case of sweet potato, 1,11,000 vine cuttings from BARI SP-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 were produced and distributed among the CIP-USAID, DAE personals, NGOs, farmers and adaptive trials. Beside this a total of 9,31,000 suckers of BARI Panikachu-1, 2, 3, 4 and 5 have been produced and distributed to DAE personals, NGOs, adaptive trials and farmers. Five tons BARI Mukhikachu-1 and one ton BARI Mukhikachu-2 have been produced and distributed during 2015-16 among the DAE personals, NGOs, farmers and adaptive trials.

Cultural Practices

Screening of potato varieties against NaCl salinity

A pot experiment was conducted at TCRC, BARI, Gazipur to assess the effect of salinity (NaCl) on growth and yield of potato under control condition. Seven levels of salinity (0,6, 8,10,12,16 and 20 dS/m) were used to evaluate twelve genotypes namely, Dura, 4.40, Omega, 4.45(W), Courage, Challenger, YP-04-80, Dolly, 9.35, 9.91, 9.112, 9.125. The plant height, tuber number, weight of tuber decreased with increased salinity levels, whereas reverse is true in case of proline content. The three genotypes namely, Omega, 4.45(W) and Courage accumulated higher amount of proline when they were subjected to higher salinity level. At 10 dS/m, Courage produced highest tuber yield (128 g/plant) followed by Challenger (107 g/plant). These two varieties also performed better and have the potentiality to survive at saline condition.

Bulking behaviour of newly released potato varieties

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2015-2016 to find out the suitable time of harvest for getting desirable yield of promising potato varieties. Six harvesting was done at 10 days interval started from 50 days after planting (DAP) and continued up to 100 DAP. Six promising potato varieties such as BARI Alu-40 (4.45w), BARI Alu-41 (5.183), BARI Alu-42 (Agila), BARI Alu-43(Atlas), BARI Alu-44 (Elger) and BARI Alu-45 (Steffi) were included in the study. Tuber yield was increased up to 100 DAP for all the varieties. The highest tuber yield (55.21 t/ha) was recorded in BARI Alu-41 (5.183) when harvested at 100 DAP, which was statistically similar to BARI Alu-40 (4.45w), BARI Alu-45 (Steffi) and BARI Alu-42 (Agila). BARI Alu-41(5.183) gave the statistically similar yield at harvest of 90 DAP and 100DAP. On the other hand, the lowest tuber yield was found in BARI Alu-43 (Atlas) when harvested at 100 DAP. The percent dry matter was increased up to 100 DAP for all the varieties. The highest tuber growth rate was found in BARI Alu-40 (4.45w), which was statistically similar to BARI Alu-41(5.183), BARI Alu-42 (Agila) and BARI Alu-45 (Steffi). The lowest tuber growth rate was recorded in BARI Alu-44 (Elger). On the other hand, the highest tuber growth rate was recorded at 60 – 70 DAP, which was statistically similar to 50 – 60 DAP. The lowest tuber growth rate was recorded at 90 – 100 DAP. It could be concluded that BARI Alu-40 (4.45W), BARI Alu-44 (Elger) and BARI Alu-45 (Steffi) showed early bulker by producing tuber yield of 38.9, 42.8 and 42.7 t/ha at 70 DAP with dry matter of 20.3, 17.7 and 17.8%, respectively.

Crop Nutrition

Determination of fertilizer dose for newly released potato varieties

Nutrient management and variety were evaluated on potato yield and soil properties at Grey Terrace soil of Gazipur and Non-calcareous Grey Floodplain soil of Debiganj. Three promising released potato varieties such as Asterix, Lady Rosetta and Sagitta were evaluated under different levels of fertilizer. The five fertilizer treatments were: T1 (RDF), T2 (125% RDF), T3 (TCRC recommended dose of fertilizer), T4 (80 % RDF + Poultry manure (PM) @ 3t ha^{-1}) and T5 (control, native nutrient). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Different fertilizer treatments and variety showed significant effect on the yield of potato over locations. The highest tuber yield was found in 125% RDF which was very closely followed by TCRC recommendation. In case of variety, Sagitta showed the maximum yield. Among the locations, the highest tuber yield was recorded in Debiganj. RDF showed the highest marginal benefit cost ratio (MBCR) (12.36%) which was closely followed by the TCRC recommendation (12.28%). Nutrient uptake by the plant and soil fertility status will be presented after having analytical value of plant and soil samples. This is the first year findings and need repeat to verify the result.

Effects of organic manure and inorganic fertilizer on yield and nutritional quality of potato

Organic manure and chemical fertilizers were tested on quality components and storability of potato tuber under different nutrient management and to study the post-harvest soil properties at Grey Terrace soil of Gazipur and Non-calcareous Grey Floodplain soil of Debiganj. There were six treatments - T1 (Control, native nutrient), T2 (100% recommended dose of fertilizers, RDF), T3 (Poultry manure, PM@ 3t ha^{-1} + rest from RDF), T4 (Cowdung, CD @ 6 t h^{-1}+ rest from RDF), T5 (125% RDF) and T6 (Farmer's practice, FP). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Yield of potato was significantly ($p \leq 0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The highest potato tuber yield (39.0 t ha^{-1}) was found in 125% RDF at Debiganj. The maximum marginal benefit cost ratio was found in 3 t PM or 6 t CD ha^{-1} + rest chemical fertilizer from RDF (Table 1). The combination of poultry manure 3 t /ha or cowdung 6 t ha^{-1} + reduced RDF was found to be better for the cultivation of potato. The highest nutrient availability was observed in 3 t PM or 6 t CD ha^{-1} + rest chemical fertilizer from RDF (Table 2).

Table 1. Effects of integrated nutrient management and locations on yield attributes and yield of potato

Location	Treat	Foliage coverage (%)	Plant height (cm)	Stem $hill^{-1}$ (no.)	Tuber $hill^{-1}$ (no.)	Wt. of tubers $hill^{-1}$ (kg)	Yield (t ha^{-1})
Debiganj	T1	55.0 f	43.9	7.50	8.80	0.30	16.5 ef
	T2	85.0 cd	74.5	10.0	11.4	0.68	36.7 ab
	T3	85.0 cd	72.0	9.60	11.9	0.65	35.6 ab
	T4	95 a	75.5	10.5	12.5	0.73	37.8 ab
	T5	90.0 a-c	78.7	11.4	12.7	0.75	39.0 a
	T6	70.0 e	66.7	8.40	10.0	0.49	32.6 b
Joydebpur	T1	50.0 f	39.0	5.40	4.10	0.25	14.5f
	T2	90.0 a-c	70.0	7.60	6.31	0.43	21.5 c-e
	T3	88.0 bc	70.5	8.00	6.62	0.49	23.3 cd
	T4	92.0 ab	78.0	9.60	7.80	0.58	26.2 c
	T5	95.0 a	74.0	8.60	6.99	0.52	24.5 c
	T6	80.0 d	60.0	6.70	5.70	0.36	19.0 d-f

Figure(s) in a column having common letter(s) do not differ significantly at 5% level.

Table 2. Effect of organic manure and chemical fertilizer on post-harvest soil properties and MBCR

Treat	pH	OM (%)	Total-N (%)	Available K (meq/ 100g soil)	Available P (ppm)	Available S (ppm)	MBCR
T_1	6.2	0.80	0.080	0.09	19	9.0	-
T_2	6.2	0.83	0.088	0.10	24	11	9.60
T_3	6.7	0.98	0.092	0.11	25	12	12.2
T_4	6.5	0.99	0.092	0.11	24	12	12.2
T_5	6.2	0.83	0.088	0.10	24	11	9.12
T_6	6.1	0.82	0.082	0.08	25	9.0	7.94
Initial value	6.4	0.88	0.090	0.11	20	10	9.60

Figure(s) in a column having common letter(s) do not differ significantly

Effect of foliar application of zinc on the yield and quality of potato

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2015-2016 to study the effect of foliar application of zinc on the yield and quality of potato. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments comprised foliar application with different concentration of Zinc such as: T_1 (0 ppm Zn), T_2 (140 ppm Zn), T_3 (280 ppm Zn), T_4 (420 ppm Zn), T_5 (560 ppm Zn) and T_6 (700 ppm Zn). The tuber yield of potato was significantly influenced by foliar application of different concentration of zinc. The highest tuber yield (34.48 t/ha) was obtained in 280 ppm Zn (Table 1).The highest dry matter of potato was found in this treatment. The highest marginal benefit cost ratio (13.54%) was also recorded in the same treatment.

Table 1.Effect of foliar application of zinc on the yield attributes and yield of potato

Treat.	Plant height (cm)	Foliage coverage (%)	Stem^{-1} hill (no.)	Tuber^{-1} hill (no.)	Tuber weight^{-1} hill (kg)	Tuber yield (t/ha)	Dry mater (%)
T_1	66.06	85.33	7.33	8.84	0.43b	28.53e	18.74b
T_2	68.93	84.66	6.20	9.71	0.47ab	31.46c	19.30b
T_3	71.46	84.66	6.67	9.88	0.52a	34.48a	21.35a
T_4	66.93	82.67	6.40	9.07	0.49ab	32.67b	20.24ab
T_5	71.33	85.00	6.60	8.20	0.47ab	31.20c	19.70ab
T_6	71.93	84.00	7.40	8.88	0.45b	30.25d	19.06b

Means followed by the same or no letter in the same column do not differ significantly each other at the 5% level

Effect of foliar application of boron on the yield and quality of potato

The boron was applied as foliar on potato at Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh under AEZ-3 (Tista Meander Floodplain Soil) during the Rabi season 2015-2016 to to evaluates its effect on the yield and quality of potato. The experiment was laid out in a randomized complete block design (RCBD) with six treatments. The treatments comprised foliar application with different concentration of Boron such as: T_1 (0 ppm B), T_2 (70 ppm B), T_3 (140 ppm B), T_4 (210 ppm B), T_5 (280 ppm B) and T_6 (350 ppm B) (Table 1). The potato tuber and dry matter yield were significantly influenced by foliar application of boron. The highest potato tuber yield (34.3 t ha^{-1}) and dry matter content (21.38 %) were found in 210 ppm B. The highest marginal benefit cost ratio (12.76) was also in this treatment.

Table 1. Effect of foliar application of boron on the yield attributes and yield of potato

Treat.	Plant height (cm)	Foliage coverage (%)	Stem / hill (no.)	Tuber / hill (no.)	Tuber weight / hill (kg)	Tuber yield (t/ha)	Dry mater (%)
T_1	71.46	87.00	7.86	9.83	0.43c	28.59e	18.82b
T_2	72.66	87.33	8.00	9.84	0.45bc	30.13d	19.38b
T_3	69.20	85.00	7.80	9.77	0.49ab	32.76b	20.03ab
T_4	69.46	89.66	7.00	10.92	0.51a	34.33a	21.38a
T_5	70.13	89.67	6.93	10.43	0.47abc	31.47c	19.62b
T_6	70.66	86.67	7.46	9.43	0.46abc	30.87cd	19.22b

Effect of nitrogen and variety on the yield and quality of potato

Three newly released potato variety such as BARI Alu-31 (Sagitta), BARI Alu-41 (5.183) and BARI Alu-45 (Steffi) were tested under five levels of nitrogen (T1 =100% RDN, recommended dose of nitrogen), T2 =125% RDN, T3 =150% RDN, T4 =175% RDN and T5 =75% RDN) at Breeder seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2015-2016. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The potato tuber yield was significantly variable among the treatments under different varieties. The highest tuber yield (54.0 t ha^{-1}) was found in 150% RDN at BARI Alu-45 (Steffi) which was followed by V1T2 (Sagitta in 125% RDN). The maximum dry matter (20.47%) was recorded in BARI Alu-41 at 175% RDN which was closely followed by BARI Alu-41 in 75% RDN). The minimum scab infection (3.24% by number) was found in BARI Alu-41 at 175% RDN which closely followed by BARI Alu-41 at 150% RDN. BARI Alu-41 in 175% RDN also showed the highest starch content (15.3%) followed by V2T4 (BARI Alu-41 in 75% RDN) and V2T1 (BARI Alu-41 in 100% RDN). This is the first year findings and needs to repeat to verify the result.

Organic cultivation

Evaluation of export quality potato varieties under organic cultivation system

An experiment was conducted to evaluate the yield and quality of some export oriented potato varieties under organic management practices. The experiment was executed at the organic block under TCRC research field, Gazipur during the year 2015-16. Ten export oriented varieties namely BARI Alu-7, BARI Alu-8, BARI Alu-13, BARI Alu-25, BARI Alu-27, BARI Alu-35, BARI Alu-41, BARI Alu-44, BARI Alu-45 and BARI Alu-46 were selected as the treatment. These varieties were evaluated under organic production system where soil fertility were managed with different organic manures like Cow dung, Vermicompost, Trichocompost, and Neem Oil Cake @ 5t/ha each and different botanicals were used to reduce the pest attack. The highest tuber yield (32.63 t/ha) was found from the variety BARI Alu-41 which was followed by BARI Alu-8 (30.4 t/ha) and BARI Alu-45 (29.5 t/ha) and were statistically identical. The highest dry matter (23.97%) and maximum BCR (1.47) was obtained from the variety BARI Alu-41. Considering all aspects, BARI Alu-41and BARI Alu-8 can be brought under organic cultivation as export purpose for global organic market. This is the first year findings and need repeat to verify the result.

Performance of some indigenous potato varieties under organic practices

An experiment was conducted to find out the yield potential of nine indigenous varieties under organic management practices at RARS, Burirhut, Rangpur. The highest tuber yield was found from the variety LalPakri (13.63 t/ha) which was followed by Shilbilati (9.147 t/ha) but statistically different while the lowest tuber yield (2.15 t/ha) was recorded in Indurkani. This is the first year findings and need repeat to verify the result.

Effects of different organic fertilizers on the yield and quality of potato processed products

This experiment was executed at the organic under TCRC, Gazipur during the year 2015-16 to assess the influence of organic fertilizers on the yield of potato and thereafter on the quality of potato chips and French fries. Performance of five organic manures namely Cowdung, Mega Organic Fertilizer, Vermicompost, Trichocompost and North Bengal Organic Fertilizer with two potato varieties e.g. BARI Alu-25 (Asterix) and BARI Alu-28 (Lady rosetta) were evaluated. North Bengal Organic Fertilizer with Lady Rosetta gave the highest yield (25.4 t/ha) which was at par with Asterix (25.33 t/ha) treated with same fertilizer and both were identical but statistically different from most of the treatments.

Pest Management

Disease Management

General survey of major potato diseases of Bangladesh

A survey was conducted to know the status of potato diseases in Bangladesh during 2015-16. Late blight, common scab and mosaic diseases are predominant, other diseases like bacterial wilt, stem rot, stem canker, black scarf, black leg and PVY were seen but not dominant during survey. Late blight disease incidence was relatively high in Bogra, Rangpur, Jamalpur and low in Munshiganj, Rajshahi, Gazipur and Khagrachari.

Efficacy of new fungicides in controlling late blight of potato

A total of 65 fungicides were tested against late blight disease of potato at three locations in Bangladesh. Sixteen fungicides in TCRSC, Bogra, 32 fungicides in RARS Jamalpur and 17 fungicides in RARS, Rangpur were used to reduce the disease under field condition. Some fungicides were excellent in controlling late blight disease. In Bogra, Formocozeb 80 WP, Agromet plus 69 WP, Mona 28 SC and Mycozeb 80 WP were promising; in Jamalpur, Agrozeb 80 WP, Achal 80 WP, Vita plus 72 WP, C.M. 75 WP, Deomil Gold 72 WP and standard fungicide Dithane M-45 were promising and in Rangpur, Cymox, Preneb, Fosta, Agromet, Orostar, Growthan, Moxamil and standard fungicides (Dithan M-45 and Secure) were better for controlling this disease.

Screening of potato germplasm against late blight under natural field condition

The experiment was conducted at TCRSC, Bogra, RARS, Jamalpur and RARS, Burirhat, Rangpur, under natural field condition during rabi season of 2015-16. In Bogra it was found that among 40 varieties/germplasm, only two (Aloutte and Carolus) showed resistant reaction and rest of all susceptible to *Phytophthora infestans*. In RARS, Jamalpur out of 42 tested materials, none of the germplasm/ varieties showed resistant reaction to late blight under field condition. In RARS, Burirhat, Rangpur, out of 27 test varieties/germplasms, all were found susceptible against late blight but the two resistant check varieties BARI ALU 46 and BARI ALU 53 was found resistant.

Screening of potato varieties and germplasm against late blight disease

During 2015-16 cropping season, screening of potato varieties/germplasms against late blight (*Phytophthora infestans*) under natural inoculum pressure were carried out in farmers' field, Khaturia, Domar, Nilphamari. Out of 20 varieties/germplasm, 2 germplasm such as Alouette and Carolus were found highly resistance. At 80 DAP, Only 14% incidence but looks quite normal was observed in Sarpomira while 46.67% incidence and 10% foliage destruction was in BARI released late blight resistant variety BARI Alu 46 (LB 7). BARI Alu 57 (8.73) showed good tolerance. BARI Alu 25 (Astrix), BARI Alu 28 (Lady Rosseta), BARI Alu 29 (Courage) and BARI Alu 37 (4.40) were very susceptible. Alouette yielded the significantly highest (35.11t ha^{-1}) which was identical with Carolus (31.23 t ha^{-1}) and BARI Alu 46 (LB 7) (30.87 t ha^{-1}) and the lowest was from Astrix (BARI Alu 25) (12.42 t ha^{-1}).

Identification of *Ralstonia solanacearum* causing brown rot of potato from different tuber and soil samples

An experiment on identification *of Ralstonia solanacearum* causing brown rot of potato was conducted in the Plant Pathology laboratory, TCRC, Gazipur, A total of 61 fresh potato tuber samples and 84 soil samples from different companies were used to isolate brown rot causing bacteria *R. solanacearum.* All soil samples provided *R. solanacearum* colonies on TZC media. In case of tuber samples, 23 tuber samples provided positively the isolates of *R. solanacearum*, whereas the rest 38 tuber samples found completely free from the bacteria. Virulent and avirulent bacteria as *R. solanacearum* were found on TZC media from the all supplied tuber and soil samples.

Screening of different BARI released varieties against common scab disease of potato

Twelve BARI released varieties including two checks as Diamant and Cardinal were evaluated at Tuber Crops Research Centre, BARI, Gazipur during 2015-16 cropping year under the field condition at Rabi season. Considering scab incidence and severity, BARI Alu-41 and BARI Alu-34 provided significantly lower scab infection than other varieties.

Effect of different management practices on the common scab disease of potato

An experiment was conducted at TCRC, BARI, Gazipur to find out the effective management practices in controlling common scab of potato var. Diamant. A total of twelve (12) treatments including farmer practice were selected. The effect of treatments varied among them to reduce common scab of potato. The treatment T_7 (Two irrigation at 30-35 DAP and 45-50 DAP) found to be more effective followed by T_1 (Rice/Wheat straw burning in the field) to control common scab based on disease the incidence and severity.

Effect of time of liming on the development of common scab and potato yield

An experiment having five treatments (liming before T. aman rice planting, liming 30 days before potato planting, liming 20 days before potato planting, liming 10 days before potato planting and no liming i.e. control) was conducted at farmer's field of Domar, Nilphamari having initial soil pH-4.79. The dose of lime was 1.0 t/ha. Use of lime significantly increased common scab disease and also slightly increased potato yield. The disease incidence and severity was found decreasing trend with increase of gap between liming and potato planting. The significantly highest disease incidence (45.98%) and severity (16.82) was recorded from liming at 10 days before potato planting. The highest yield (36.97 t/ha) was obtained from liming before rice cultivation whereas treatment and the lowest (33.21 t/ha) in without liming treatment.

Effect of different management practices on the common scab disease of potato

Twelve different management including farmer’s practice were evaluated for managing common scab of potato caused by *Streptomyces* spp. in BSPC, Debiganj, Panchagarh during 2015-16 cropping season. Two irrigations (15 and 35 DAP) were common in all treatments except irrigation and farmers practice treatment. Plant emergence (%), disease incidence (%), disease severity (PDI) and tuber yield (t/ha) was significantly influenced by different management practice. Delayed emergence was observed in boric acid treated plots. The least disease incidence (4.86%) and severity (1.20) was found in rice straw burning treatment and it was insignificant with furrow treated with 3% boric acid before planting, seed treated with 3% boric acid and both seed and furrow treated with 3% boric acid treatment. The highest yield 31.46 t ha^{-1} was harvested from two irrigation at 15 and 35 DAP treatment and it was insignificant with all except furrow treated with 3% boric acid before planting (19.03 t/ha) and both seed & furrow treated with 3% boric acid (11.90 t/ha).

Screening of potato varieties against soil borne diseases (common scab, stem canker and black scurf)

Twenty potato varieties were evaluated against common scab and black scurf disease under natural field conditions at farmers' field, Khturia, Domar, Nilphamari during 2015-16 cropping season. Significant variation among the varieties was pronounced in tested parameters. No varieties was found resistant to *Streptomyces* spp.. The significantly lowest common scab disease incidence (0.58%) and severity (0.11%) was recorded from BARI Alu-56 (8.46), it was statistically similar with Courage (BARI Alu-29), BARI Alu-36 (4.26 R), BARI Alu-41 (5.183), BARI Alu-46 (LB-7), BARI Alu-53 (LB-6), BARI Alu-59 (Metro) and BARI Alu-61 (Volumia) while the highest disease incidence (25.43%) and severity (8.50%) was in Cardinal and it was significantly higher than some other varieties. Nine varieties like BARI Alu-13 (Granola), BARI Alu-31 (Sagitta), BARI Alu-35 (4.5 W), BARI Alu-36 (4.26 R), BARI Alu-40 (4.45 W), BARI Alu-46 (LB-7), BARI Alu-53 (LB-6), BARI Alu-60 (Vivaldi) and BARI Alu-61 (Volumia) showed no disease symptom of black scurf. The highest incidence (28.04%) and severity (13.25%) was recorded in BARI Alu-29 (Courage) was significantly higher than others. Significantly highest (49.05 t/ha) and lowest (31.52 t/ha) tuber yield was recorded from BARI Alu-40 (4.45 W) and BARI Alu-29 (Courage), respectively.

Screening of advanced CIP potato clones against virus diseases

A total of eight CIP clones were evaluated against PLRV and PVY to find out resistant source (s) for releasing the suitable tolerant varieties at Gazipur. Data on percent PLRV and PVY incidence, germination and yield were taken in this year. In growing on test during 2015-16, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameters, CIP-126 performed better in this year. The experiment will be repeated in the next season.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (first progeny)

Eight exotic potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) for releasing the suitable tolerant varieties at Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in this year. In growing on test, both PLRV and PVY infection was found free from the all tested varieties. Colomba and Fortus performed better for their higher plant vigourity and yield. The experiment will be repeated in the next season.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (second progeny)

Thirteen exotic potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) at Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2014-15. Data were taken on percent PLRV and PVY incidence, germination and yield. In growing on test during 2015-16, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameters, Memphis performed better in this year. The experiment will be repeated in the next season.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (third progeny)

Six exotic potato varieties were evaluated against PLRV and PVY to find out resistant source (s) at Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2013-14. Data were recorded on percent germination, PLRV, PVY, Yield and plant vigour. In subsequent growing up test during 2015-16 as the third generation, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameter, only one variety namely Camel was found to be better for showing free to very lower infection PLRV and PVY.

Variability of morphological symptoms and serological detection of virus diseases of potato

A total of 80 plant samples from 21 different CIP clones, lines and existing potato varieties were evaluated for conducting variability of morphological symptoms and serological detection of virus diseases ofpotato at TCRC, Gazipur. All leaves showed either positive or negative reaction by DAS-ELISA test and indicated the viruses as single and mixed. Some leaves gave negative reaction to virus that means virus free, though symptoms were present on that leaves. Identified viruses were found as single and mixed infection of PLRV, PVY, PVM, PVX and PVS. Out of the 80 samples, 22 had single virus infection, 35 had double virus infections and 15 had triple virus infections. Single viruses, namely, PVY, PVS, PVX, and PLRV were found as single and their incidence was 5, 2.5, 15 and 5%, respectively. The most common mixed infection was PVX+PVY(35%) and PVS+PVX+PVY (10%). Other common combinations were, PLRV+PVX+PVY(5%), PVS+PVY(3.75%), PLRV+PVX(2.5%), PLRV+PVS (1.25%) and PVY+PVS+PVM(1.25). PVM were not detected as single infection.

Survey on the status of potato cyst nematodes in Bangladesh

A survey was conducted during 2015-16 in four different locations of potato growing areas of Bangladesh to examine the presence or absence of cyst nematode in potato. Cyst nematode was not found in all four locations.

Insect Management

Development of integrated management package's for the control of potato tuber moth (PTM) in storage condition

The experiment was conducted in storage room non- refrigerated rustic (with an average room temperature ranging from 24.5^0 C to 37.8^0 C and relative humidity 30% to 98%) at Gazipur location. After harvest potato tuber covered with net before set the experiment. The experiment was set at April 1, 2015 and laid out in Completely Randomized Design (CRD) with three replications and along with six treatments. Sex pheromone along with dry sand and Neem oil cake (T_4) showed the lowest percent of tuber damage by weight (14.43%). The numbers of infestation holes were also counted per tuber to show the severity of infestation per tuber and the lowest number of holes per tuber (0.95) was also found in that treatment. The highest percent of rottage loss (6.93%) was recorded in T_1 + Potato tuber covered with thin layer of dry sand (T_2) treatment. The number of PTM increased drastically up to and 4^{th} week of May and 1^{st} week of June where the PTM population reached accordingly 120.3M /T and 112.1M/ T. During the cool season PTM populations remain low and do not cause significant damage to potato tubers. However, populations develop quickly from the beginning of April with the onset of hot and dry weather. Therefore, finding from the study T_4 (Pheromone + Dry sand + Neem oil cake) may be environmentally safer and effective for PTM management. Moreover the tuber shape and quality was also good and resulted in normal sprouting in non refrigerated storage trials was quite successful up to 4 months.

Post harvest Technology

Storage

Storage behaviour of potato varieties and hybrid clones under natural condition

An experiment was conducted during March to August 2015. Tubers of exotic potato varieties and clonal hybrids of RYT, AYT and SYT were evaluated for storage behavior under natural condition. Fourteen exotic varieties of RYT were evaluated among them Royal, Atlantic, Pamela and Flova were performed better showing minimum weight and rottage loss and retained almost original colour with good marketability up to five months of storing while hybrid clones of RYT the clones of 9.91 and 9.125 showed better performance. Regarding AYT, among nine clonal hybrids the clones of 10.105 and 10.58 showed good storage performance. In exotic varieties Tomensa, Svenja, Barcelona, Caruso, Rumba and Connect showed better performance. Regarding secondary yield trial (SYT), among nine exotic varieties (Bafana, Camel, Figaro, Forza, Modoc, Red Sunset, Teton Russet, Verdi and YuKon Gem), Teton Russet and Forza showed good performance with the clonal hybrids of 11.68 and 11.95.

Storage behaviour of potato varieties included regional yield trial (RYT) of exotic varieties

Fourteen exotic varieties of RYT namely Challenger, Flaminco, Flova, Gorgina, Kufiri Joti, Pamela, Rosagold, Royal, Safrana, Sarpomira, Atlantic, Crips 4all, Destiny and Dolly were evaluated in this experiment. At 150 DAS (days after storage), the minimum weight loss (15.78%) was observed in Pamela followed by Flova (21.87%), whereas the maximum weight loss (88.39%) was found in Doly followed by Challenger (71.38%) and Flaminco (62.72%). At 150 DAS, the maximum bacterial soft rot percentage (56.15%) was observed in Sarpomira followed by Gorgina (54.39%) and the minimum was found in Pamela (8.43%) followed by Atlantic (21.39) and Royal (21.63%). The maximum FDR (2.64%) was observed in Flaminco closely followed by Dolly (2.53%) and Atlantic (2.37%), and minimum (0.71%) was in the varieties of Challenger, Flova, Rosagold, Crips 4all and Destiny at 150 DAS. At 150 DAS, the degree of sprouting was minimum (score 2.0) in Gorgina and Dolly and maximum (score 4.0) was observed in Challenger, Flova, Kufri Juti and Rosa gold. Size of the sprouts was minimum (score 2.0) in Gorgina (2.0) and the maximum (score 4.0) was in Challenger, Kufri Juti and Rosa gold. Loss of colour was minimum (score 4.0) in Gorgina and Pamela whereas maximum (score 1.0) was reordered in Kufri Juti. Good marketability was found in Gorgina and Pamela which was obtained maximum score of 4.0 whereas Kufri Juti exhibited poor marketability with the score of 1.0.

Storage behaviour of potato varieties included regional yield trial (RYT) of hybrid clones

Four hybrid clones of RYT namely 9.112, 9.125, 9.35 and 9.91 were evaluated in this experiment. At 150 DAS, the minimum weight loss (34.73%) was found in clonal hybrid 9.91 and the maximum (59.54%) was in clonal hybrid 9.35. The data showed that all the tubers were rotten in the clonal hybrid 9.35 before 150 DAS. At 150 DAS, the minimum rottage loss (27.28%) due to bacterial soft rot (BSR) was observed in hybrid clone 9.91 whereas the maximum rottage loss (59.97%) was recorded in the hybrid clone 9.35 (Table 6). On the contrary, the data revealed that *Fusarium* dry rot was minimum in all the tested hybrid clones. The highest Fusarium dry rot (1.86%) was observed in the hybrid clone 9.91 and the lowest was in the hybrid clone 9.35. At 150 DAS, degree of sprouting and size of sprouting were minimum in 9.112 (score 1.0). Tuber shrinkage of all the hybrid clones were same (score 2.0). Loss of colour was minimum (score 4.0) in 9.112. The highest weight of sprouts (45.65g) was recorded in 9.91. Good marketability was found in 9.112

Storage behaviour of potato varieties included advanced yield trial (AYT) of exotic varieties

Ten exotic varieties namely YP-04-80, Bercelona, Connect, Caruso, Cumbica, Endeavaur, Montecurlo, Rumba, Svenja and Tomensa were evaluated in this experiment. At 150 DAS the minimum weight loss (25.15%) was in Tomensa and closely followed by Rumba (25.22%). The maximum weight loss (70.98%) was observed in Montecurlo. After 150 DAS, total rottage loss for bacterial soft rot was maximum (49.3%) in Endeavour followed by YP-04-80 (44.6%) (Table 14). The highest FDR % was observed in YP-04-80 (3.74%). The minimum (0.71%) was observed in Montecarlo, Cumbica and Connect. At 150 DAS, Rumba and Svenja showed the minimum degree of sprouting (score 2.0). The size of sprout was the highest in Tomensa (score 4.0). The maximum shrinkage (score 4.0) was observed in Tomensa. The minimum colour loss was observed in Bercelona, Rumba, Montecurlo and Svenja. Good marketability was also observed in Bercelona, Rumba, Montecurlo and Svenja.

Storage behaviour of potato varieties included advanced yield trial (AYT) of hybrid clones

Nine clonal hybrids namely 10.3, 10.35, 10.58, 10.59, 10.90, 10.105, 10.116, 10.245 and 10.275 were evaluated in this experiment. At 150 DAS, the minimum weight loss (19.72%) was recorded in hybrid clone 10.105 followed by 10.58 (29.29%).The maximum weight loss (95.31%) was observed in the hybrid clone 10.59. The results demonstrated that all the tubers were rotten before 150 DAS in the hybrid clone 10.116. At 150 DAS, the bacterial soft rot percentage was found minimum (14.70%) in 10.105. The maximum BSR rottage (66.22%) was found in 10.116 (Table 10). The FDR percentage was highest (2.66%) in hybrid clone 10.35 and the minimum (0.71%) was in 10.116. At 150 DAS, the degree of sprouting was maximum (score 3.00) in hybrid clones of 10.3, 10.59, 10.9, 10.105, 10.245 and 10.275. Similarly, the size of sprout was found the highest in the above stated clonal hybrids. The minimum degree of shrinkage (score 1.0) was observed in hybrid clone 10.58 and no loss of colour was exhibited in the hybrid clone 10.58 (score 5.0). Good marketability was also observed in 10.58 (score 5).

Storage behaviour of potato varieties included secondary yield trial (SYT) of exotic varieties

Nine exotic varieties viz. Bafana, Camel, Figaro, Forza, Modoc, Red Sunset, Teton Russet, Verdi and YuKon Gem were evaluated in this experiment. At 150 DAS, the minimum weight loss (42.60%) was found in Forza followed by Teton Russet (51.23%). The maximum weight loss (95.35%) was recorded in Yukon Gem (Table 17). The data revealed that all the tubers were rotten before 150 DAS mainly due to BSR in Bafana, Modoc, Red Sunset and Verdi. At 150 DAS, the maximum bacterial soft rot (66.64%) was found in Verdi. The minimum rottage loss was (31.40%) observed in Forza. The maximum *Fusarium* dry rot (2.87%) was found in Yukon Gem and the minimum (0.71%) was in Figaro, Modoc and Red Sunset. At 150 DAS, the degree of sprouting was minimum (score 1.0) in Red sunset. All the varietiesexcept Red Sunset and Camel showed the maximum (score 3.0) size of sprout. The degree of shrinkage did not differ among the varieties except Camel, Vardi and Red sunset (2.0). Loss of colour was the minimum score (3.0) in Camel and Red sunset. Bafana, Camel and Red Sunset showed the good marketability.

Storage behaviour of potato varieties included secondary yield trial (SYT) of hybrid clones

Ten clonal hybrids viz.11.35, 11.5, 11.68, 11.77, 11.80, 11.88, 11.93, 11.95, 11.99 and 11.105 were evaluated in this experiment. At 150 DAS the minimum weight loss (27.58%) was found in 11.68 followed by 11.95 (29.28 %). The data showed that all the tubers were rotten before 150 days in hybrid clones of 11.35, 11.77 and 11.105. At 150 DAS, the minimum bacterial soft rottage (9.41%) was found in 11.68 followed by 11.95 (16.21%). The maximum BSR (57.34%) was observed in 11.77 (Table 22). The data revealed that *Fusarium* dry rot was minimum. The highest FDR (4.14%) was observed in hybrid clone 11.5 and lowest (0.71%) was in the clones of 11.68, 11.77 and 11.99. At 150 DAS, the degree of sprouting was minimum in all the genotypes (score 3.0). Size of the sprout was the minimum (score 2.0) in 11.35 and 11.68. Loss of calour was the minimum (score 3.0) in 11.68 and 11.77. Good marketability was also-observed in 11.68, 11.77, 11.80, 11.88 and 11.93.

Processing

Studies on the processing quality (chips and French fry) of potato cultivars and hybrid clones

Five exotic varieties of RYT (Bercelona, Montecarlo, YP-04-80, Caruso and Tomensa) were studied for their processing quality into Chips and French Fries. Montecarlo and Tomensa showed better performance in both of chips and French fries, whereas Caruso only for French fries and YP-04-80 for chips. Three exotic (Camel, Yukon Gem and Verdi) and three clonal hybrids (10.245, 10.116 and 10.58) under AYT were evaluated. Among them Camel and hybrid clone 10.245 exhibited better performance in both of chips and French fries whereas Verdi and 10.58 showed better only for French fries and Yuken Gem for chips. Thirteen exotic varieties (Rosi, Panama, Cimega, 7 four 7, Farida, Jelly, Memphis, Taisiba, Montreal, Canbera, Coronada, Navigator and Granola) and eight clonal hybrids (11.68, 11.99, 11.93, 11.8, 11.77, 11.105, 11.95 and 11.5) under SYT were evaluated among them hybrid clone 11.105 showed better performance both in chips and French fries whereas Jelly, Panama, Canberra and hybrid clone 11.77 only for French fries and Navigator, Coronada and hybrid clone 11.95 for chips.

Sweet Potato

Varietal Improvement

Hybridization of sweet potato using random mating cross

Hybridization is a routine program of TCRC by which we can develop variability and screening for variety with high yield, high carotene and high dry matter content. Vitamin A deficiency is a major problem in Bangladesh. To combat with this malnutrition and vitamin A deficiency, Orange Fleshed Sweet Potato (OFSP) may be one of the tools. A crossing program was under taken during 2015-16 at Gazipur to develop variety(s) with high yield, dry fleshed and moderate carotene content. Thirteen parents were included in this study. Only ten parents produced F_1 seeds. The highest number of F_1 seeds was collected from BARI SP-11 (204), followed by Belgium (64) and the lowest number of F_1 seeds produced by BARI SP-6 (7). These F_1 seeds will be sown in nursery bed next season for vine as well as tuber production and evaluation.

Observational trial with F_1C_0 hybrid clone of sweet potato

An observational trial was initiated using vines derived from seeds and hybrid clones F_1C_0 of sweet potato at Gazipur during 2015-16 cropping season. Vines derived from seeds were planted in the field for evaluation. Out of thirty eight (38) F_1C_0 hybrid materials fifteen (15) clones were selected as promising for next year evaluations.

Observational trial of newly introduced polycross seeds

To create variability of different characters like early bulking, carotene and anthocyanin containing, high dry matter, starch containing and weevil tolerance, International Potato Centre (CIP) has taken initiatives in Asian sweet potato growing countries under a network. At Mozambique they produced poly cross of 21 families and send to TCRC for use in breeding program. A total 3290 polycross seeds of 21 families were sown in nursery bed for germination. Seeds of all polycross were germinated and germination ranged from 10-82.50%.

Preliminary evaluation of newly introduced 46 CIP clones of sweet potato

TCRC received 46 CIP clones of sweet potato in 2014 having different characters like early bulking, carotene containing, weevil tolerant. The preliminary evaluation trial was done with newly introduced forty six CIP clones in 2015-16 growing season. Sixteen genotypes exhibited early bulker out of forty six. Twenty two genotypes showed weevil tolerance in nature during harvest. As it was first year performance it will need further observation for better selection of genotypes

Preliminary yield trial with F_1C_3 hybrid clone of sweet potato

From last year trial (2014-15), 10 promising lines were selected from 22 clones for preliminary yield trial. This year (2015-16) a field trial was conducted using 10 previous promising lines at Gazipur. Based on high yield , carotene content and dry fleshed, 8 lines were selected namely, $H_{01.10}$/12 $H_{01.12}$/12, $H_{01.13}$/12 $H_{2.7}$/12, $H_{2.13}$/12 ,$H_{9.6}$/12 ,$H_{9.7}$/12 and $H_{9.10}$/12 were be selected for next year trial.

Secondary yield trial with F_1C_4 hybrid clones of sweet potato

A field trial was done to evaluate 21 hybrid clones at Gazipur during 2015-16 cropping season. Following the selection procedure this 21 hybrid clones was selected from last year trial (2014-15) where 55 clones were evaluated. Among the 21 tested clones nine hybrid clones namely, $H_{6.13}$/11, $H_{6.49}$/11, $H_{6.52}$/11, $H_{9.13}$/11, $H_{9.40}$/11, $H_{9.43}$/11, $H_{9.48}$/11, HPK_{40}/11 and $HPK_{219.1}$/11were selected based on marketable yield, dry matter content, carotene content and overall acceptability score.

Secondary yield trail of F_1C_5 hybrid clones of sweet potato

A trial was initiated at Gazipur during 2014-15 cropping season. The hybrid clones were planted in the field for evaluation. Out of fifteen (15) clones following the selection procedure nine (9) clones were selected as promising for next year evaluations. These 9 clones were set into SYT trial in 2015-16 to find out suitable sweet potato clones having high yielding, carotene rich and dry fleshed. Considering marketable yield, dry yield, dry matter (%), carotene content, overall acceptability score and other factors six hybrid clones namely, $H_{4.01}$/10, $H_{11.01}$/10,H_5.ej/10, H_8.ej/10, H_{16}.ej/10 and H_{17}.ej/10 were selected for next year evaluation.

Regional yield trial with F_1C_7 hybrid clones of sweet potato

Three promising clonal hybrid namely H_2/08,H_5/08, H_{47}/08 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 201516 cropping season at five different agro ecological environment /locations in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of sweet potato. The hybrid clone H_5/08 yielded highest (38.37t/ha) followed by H_{47}/0 (35.02 t/ha) (Table 1). All of the tested clones gave higher yield than the controls. Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these two hybrid clones namely H_5/08 and H_{47}/08 were selected for confirming performance on next year trial.

Table 1.Interaction effect of genotype and location and genotype mean over locations on marketable tuber yield (t/ha) and dry matter (%) of sweet potato under RYT during 2015-16

Variety/ Clones	Marketable tuber yield (t/ha)					
	Gazipur	Bogra	Pahartali	Jessore	Jamalpur	Mean
H_2/08	27.78 hi	37.87 d-g	33.83 e-h	15.65 jk	41.84 c-e	31.40 bc
H_5/08	28.89 g-i	39.92 d-f	34.22 e-h	20.30 ij	68.51 a	38.37 a
H_{47}/08	30.55 gh	43.93 b-d	34.54 e-h	15.68 jk	50.37 bc	35.02 ab
BARI SP-4	31.30 f-h	37.82 d-g	31.53 f-h	11.53 jk	33.901 e-h	29.21 c
BARI SP-8	27.22 hi	37.38 d-g	29.22 g-i	7.77- k	51.11 b	30.54 c
H_2/08	22.00 b-d	14.54 i	22.00 b-d	29.40 a	18.30 f-h	21.25 bc
H_5/08	23.00 b	16.54 hi	21.00 b-e	22.33 b-d	27.70 a	22.12 ab
H_{47}/08	21.33 b-e	17.32 gh	20.67 b-f	20.33 c-f	16.57 hi	19.25 d
BARI SP-4	19.00 e-g	14.57 i	20.67 b-f	22.67 bc	27.60 a	20.90 c
BARI SP-8	21.33 b-e	16.54 hi	20.00 d-f	29.13 a	28.83 a	23.17 a

Regional yield trial with CIP clones of sweet potato

Three promising CIP clone namely CIP-441132,CIP-194513.15, CIP-440267.2 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2015-16 cropping season at five different agro ecological environment/locations in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of sweet potato. The clone CIP-441132yielded the highest (36.23 t/ha) followed by CIP-194513.15 (35.15 t/ha) and lowest yield BARI SP-4 (30.37 t/ha) (Table 1). Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these two CIP clones namely CIP-441132 and CIP-194513.15 were selected for confirming performance on next year trial.

Table 1. Interaction effect of genotype and location and genotype mean over locations on marketable tuber yield (t/ha) and dry matter (%) of sweet potato under RYT during 2015-16

Variety/ Clones	Marketable tuber yield (t/ha)					
	Gazipur	Bogra	Pahartali	Jessore	Jamalpur	Mean
CIP-441132	30.37 g	44.95 a-c	40.88 b-e	22.37 h	42.59 b-d	36.23 a
CIP-194513.15	32.78 fg	37.97 c-f	36.91 d-g	17.37 hi	50.73 a	35.15ab
CIP-440267.2	31.30 fg	37.14 d-g	38.52 b-f	30.97 fg	34.07 e-g	34.40ab
BARI SP-4	36.11 d-g	31.36 fg	36.67 d-g	9.96 i	37.77 c-g	30.37 c
BARI SP-8	32.41 fg	32.47 fg	41.11 b-e	12.15 i	45.92 ab	32.81 bc
Dry matter (%)						
CIP-441132	23.87de	22.33f-h	22.00 g-i	30.13 a	24.97 d	24.66 a
CIP-194513.15	22.83e-g	18.85 l	21.00 i-k	29.07 ab	20.30 jk	22.41 b
CIP-440267.2	23.33 ef	16.08 m	20.33 jk	26.40 c	23.40 ef	21.91 bc
BARI SP-4	20.00 kl	16.08 m	20.67 jk	22.73 e-g	28.67 b	21.63 c
BARI SP-8	23.70 de	20.80 i-k	21.33 h-j	28.87 ab	28.63 b	24.67 a

Participatory variety selection trial with F_1C_7 hybrid clones of sweet potato

A participatory variety selection trial at farmer's field of Gazipur,Bogra,Pahartali,Jamalpur and Jessore was carried out with three hybrid clones namely H_2/08, H_5/08 , H_{47}/08 and two check variety BARI SP-4 and 8 during the winter season of 2015-16. From the mean yield of three locations the highest yield (30.33 t/ha) was obtained by H_5/08 and the lowest (22.77 t/ha) in H_2/08 (Table 1).

Table 1. Yield (t/ha) of F_1C_7 hybrid clones of sweet potato at farmers field, 2015-16

Hybrid clones/varieties	Tuber yield (t/ha)					Mean
	Gazipur	Bogra	Pahartali	Jamalpur	Jessore	
H_2/08	23.0	16.87	22.00	32.77	16.70	22.27
H_5/08	33.50	33.14	20.00	44.99	20.00	30.33
H_{47}/08	29.00	26.05	21.00	36.84	25.60	27.70
BARI SP-4	28.90	29.59	20.00	39.44	15.00	26.59
BARI SP-8	29.50	39.66	20.00	33.51	13.30	27.19

Farmer`s reaction

Hybrid clone H_5/08 gave higher yield than the check BARI SP-4 and 8. Farmers of all locations like the clone H_5/08 due to purple skin and moderate orange flesh colour, good shape, size and taste. Vine availability should be ensured.

Participatory variety selection trial with CIP clones of sweet potato

A participatory variety selection trial at farmer's field of Gazipur, Bogra, Pahartali, Jamalpur and Jessore locations was carried out with three CIP clones namely CIP 441132,CIP 194513.15 and CIP 440267.2 with two check variety BARI SP-4 and 8 during the winter season of 2015-16. From the mean yield of three locations the highest yield (31.50 t/ha) was obtained by CIP 194513.15 and the lowest (23.27 t/ha) in BARI SP-4 (Table 1).

Table 1. Yield (t/ha) of CIP clones of sweet potato at farmers field, 2015-16

Hybrid clones/varieties	Tuber yield (t/ha)					Mean
	Gazipur	Bogra	Pahartali	Jamalpur	Jessore	
CIP 441132	32.50	27.91	28.00	33.10	25.50	29.4
CIP 194513.15	30.50	24.41	26.00	53.30	23.30	31.5
CIP 440267.2	27.90	19.76	25.00	32.00	20.00	24.93
BARI SP-4	28.00	27.75	18.00	24.80	17.80	23.27
BARI SP-8	31.00	30.03	18.00	42.00	17.20	27.65

Farmer's reaction

All the tested material performed well in farmers' field condition and the yield were at per. But farmers like the hybrid clone CIP 194513.15due to red skin and orange flesh colour, good shape and taste.

Collaborative activities of sweet potato with TCRC & CIP

Screening of sweet potato varieties for salt tolerance

The present experiment was conducted with six BARI released sweetpotato varieties including a local cultivar as checked in Satkhira and Kuakata, Patuakhali during 2015-16 cropping seasons for their suitability and yield potentiality in saline soils. It was observed that all the studied variety of BARI performed better in a range of salinity level 4.22-11.53 dS/m at Satkhira and 1.05-9.55 dS/m at Kuakata, Patuakhali during the crop growing period on November 2015 to March 2016. Comprising both the locations, BARI SP-6 produced the highest yield (32.56 t/ha) followed by BARI SP-4 (30.43 t/ha) & BARI SP-12 (28.35 t/ha) while the lowest was recorded in BARI SP-13 (20.22 t/ha) followed by BARI SP-8 (21.19 t/ha). Considering the average yield performance of the variety in 2012-13, 2013-14, 2014-15 and 2015-2016 cropping season, all the BARI released varieties performed better up to 11.53 dS/m soil salinity level and average yield was more than 21 t/ha in Satkhira and Patuakhali districts. However, among the varieties studied from 2013 to 2016, BARI SP-4 produced the highest mean yield (31.20 t/ha) followed by BARI SP-6 (29.55 t/ha) and BARI SP-12 (27.47 t/ha).

Participatory selections of orange fleshed sweet potato (OFSP) advanced clones

Four CIP promising clones, two TCRC OFSP hybrid clones, two newly BARI released varieties BARI SP-12 and BARI SP-13 along with BARI SP-3, BARI SP-4 as check were evaluated at research stations and farmers' fields of Barisal, Jessore and Chittagong regions of Bangladesh following Mother & Baby trial approach during 2015-16 cropping season. The crop was evaluated at vegetative and harvesting stage both in research station and farmers' field. Farmers, scientists and extension staffs were expected that the sweet potato varieties should have the characters like, disease & insect resistance, dwarf plant with medium and erect canopy, vigorous plant, leaves are suitable for vegetable, year round cultivable, higher yield, good in taste, orange fleshed and high storability. Results at vegetative stage showed that, BARI SP-4 ranked first followed by $H_{9.6/09}$ (2^{nd}) and CIP 441132 (3rd) in Barisal, while in Jessore CIP 194513.15 got highest preference, followed by $H_{9.6/09}$& BARI SP -12 (2^{nd}) and BARI SP-13 (3^{rd}) among all the studied clones/varieties. On the other hand, in Chittagong, CIP 440267.2 ranked first, $H_{16.2/09}$ second and BARI SP-13 ranked third. At harvesting stage, participants' preferred TCRC hybrid $H_{9.6/0,}$ CIP 441132, CIP 194513.15, CIP 194515.15 and BARI SP-4 both in farmers and research station evaluation of Barisal, Jessore and Chittagong. Considering appearance of the roots after boil, flesh color, taste, presence of fiber and flesh texture during organoleptic evaluation of the harvested clones, CIP 194513.15 ranked first followed by BARI SP-13, BARI SP-12, and CIP 441132, while farmers' choice was the poorest to BARI SP-3 followed by CIP 194515.15. Yield performance of the mother trials among 3 locations, CIP 194513.15 (23.48 t/ha) being the highest yielder followed by BARI SP-4 (22.47t/ha) and CIP 440267.2 (22.35 t/ha), on the other hand, the lowest was recorded in BARI SP-13 (15.97 t/ha) and BARI SP-3 (16.83 t/ha). From the mean of all baby trials, CIP194513.15 and $H_{16.2/09}$ found as the high yielding genotypes (15.55 t/ha) followed by $H_{9.6/09}$, CIP194515.15 (14.69 t/ha), and CIP-440267.2 (14.62 t/ha) in all the locations.

Participatory variety evaluation of BARI released OFSP varieties under Gaibandha condition

A participatory variety evaluation trial with six BARI released OFSP varieties was conducted at farmers' field of Fulchhari upazila under Gaibandha district during 2015-16 cropping season for comparing yield potentiality and community level acceptability of the varieties under different agro climatic condition. The result showed that BARI SP-12 produced the highest yield (29.93 t/ha) followed by BARI SP-4 (21.41 t/ha) while BARI SP-13 gave the lowest (8.04 t/ha) yield followed by BARI SP-6 (13.07 t/ha). The crop was evaluated at vegetative and harvesting stage at farmers' field. Farmers, scientists and extension staff expected that the upcoming sweetpotato varieties would have the characters like, leaves tasty as vegetable, vigorous and healthy plant, short duration, high yield, good taste and high storability. Results at vegetative stage revealed that, BARI SP-12 ranked first followed by BARI SP-8 (2nd) and BARI SP-4 (3rd). At harvesting stage, participants' preferred BARI SP-4 as first, BARI SP-12 as second and BARI SP-8 as third. Considering appearance of the roots after boil, flesh color, taste, presence of fiber and flesh texture during organoleptic evaluation of the harvested varieties, participants' choice was the highest to BARI SP-13 followed by BARI SP--4 and BARI SP-7 while participants' choice was the poorest to BARI SP-6 followed by BARI SP-12. Considering growth, yield and evaluation at different stages, this experiment will be repeated in the next year for getting concluding result.

Promotion and dissemination activities of sweet potato arranged by CIP at different location of Bangladesh

Promotion and dissemination of high yielding, nutrient rich orange fleshed sweetpotato (OFSP) varieties in farmers' fields

In 2015-16 cropping season, 4,500 farmers (female 4,079 and male 421) from Faridpur, Gaibandha and Satkhira districts received training in September-October, 2015 on improved production technology of OFSP and their nutritional importance in daily diet. All the farmers plated vines of BARI SP-4 for root production on November-December 2015 in 5 decimal of land. On an average 22.19 t/ha yield was obtained by the farmers. Most of the farmers used the OFSP roots for consumption and few were distributed to neighbors & relative and rest sold in the local market.

Developing women entrepreneurship through establishing sweet potato vine nurseries at project sites

To ensure the supply of quality planting material for the projects target beneficiaries in 2016 crop season, 300 OFSP vine multiplication nursery were established by the women farmers. Up to March 2016, in total 5,750,000 number of sweet potato vine cuttings were sold from the nurseries with a total amount of BDT 2,875,000. On an average every nursery owner sold 19,166 vines cuttings with an average earning of BDT 9,583. Earning from their nursery business are being used in different IGA activities like-poultry rearing, tree plantation, land mortgage for crop production etc. They also shared their earnings with their husband to meet up daily household expense and expenses for their child education & treatment. Field survey suggested that most of them are now socially empowered and actively taking part in household decision making process. All the nursery owners are very happy with their present position and will continue the business, hence quality planting material of sweet potato, as well as their extra income will be ensure.

Field days and taste testing of OFSP adaptive trials

Ten field days and taste testing program were organize by the partner organization (BRAC and PROSHIKA) in three districts during harvesting time on March, 2016 in order to create awareness on OFSP root production as well as consumption promotion among the farmers. All the field days were organized in nearby farmer's field so that non-beneficiary farmers can see the production status easily. A total of 1000 (800 female and 200 male) framers and extension staffs were present in the field day and taste testing program. In every event, one sweet potato demonstration plot (5 dcml) was harvested; yield data was recorded and converted to per hectare of land. On an average, 31.88 t/ha yield was observed from all the field day programs. Experts from DAE, BARI, BRAC and PROSHIKA and lead farmers were also invited and briefly expressed their views and shared knowledge on importance of sweet potato leaves and roots in their daily diets. For consumption promotion and raise awareness on use of Orange Flesh Sweet potato (OFSP) among the local people, various recipes (more than 20 recipes) were prepared, demonstrated and tasted by the farmers and participants in each field day program.

Promotion of nutrition awareness and OFSP consumption among the students

The objective of this initiative is to increase student awareness about nutritional value of OFSP, foster behavior change through child to parent communication, and to extend OFSP production (leaves and roots) to selected schools and students home gardens. Though this approach, the project reached 2,935 students and their parents through seven promotional activities. Project implementing partner BRAC had selected seven primary schools in Gaibandha and Satkhira districts for this activity. After the children were taught on hand washing and proper hygiene preparation, each received 100-125 g of boiled OFSP/day at Tiffin time for 8 alternate days. At the closing of consumption day, all the parents' received 40 vine cuttings for homestead vine multiplication.

Orange fleshed sweet potato market linkage in Bangladesh

As part of value chain promotion, a market survey was conducted at regional and national levels to help the farmers to establish linkages with different stakeholders across the supply chain of OFSP. In order to sell the farmer's produce and link them into urban markets, the project facilitated to make a contract between lead farmers/aggregators and three super shops of Dhaka like Agora, Meena Bazar and Cantonment Super Stores (CSD). As per agreement, the project farmers supplied 4,500 kg of BARI SP-4 roots during April to May, 2016. About 15 MT of OFSP roots were also sold in Gaibandha and surrounding Upazila town through mobile van selling activity that initiative had been taken by CIP Bangladesh with the help of small van selling traders of the district. Marketed OFSP created huge demand among the urban consumers of Dhaka and Gaibandha.

Evaluation of sweet potato varieties/germplasms for resistance to virus diseases

An experiment was conducted to screen the sweet potato lines against different virus diseases in 2015-16 cropping season at Tuber Crop Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Twenty four sweet potatoes germplasm were evaluated including three check varieties (BARI SP-11, BARI SP-12 and BARI SP-13). In respect of lower virus infection and higher yield, H2.2/09 was found to be the best line among the germplasms.

Cultural Practices

Crop Nutrition

Integrated nutrient approach for yield storability and nutritional quality of sweet potato

Organic manure and chemical fertilizers were evaluated on the yield, quality component and storability of sweet potato under integrated nutrient management at Grey Terrace soil of Gazipur and Tista Meander Floodplain soil of Bora. There were six treatments - T_1 (Control, native nutrient), T_2 (100% recommended dose of fertilizers, RDF), T_3 (Poultry manure, PM@ 3t ha^{-1}+ rest from RDF), T_4 (Cowdung, CD @ 6 t h^{-1}+ rest from RDF), T_5 (125% RDF), T_6 (Farmer's practice, FP). The yield of sweet potato was significantly ($p \leq 0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The highest root yield (23.5 t ha^{-}1) was obtained in T3 at Gaziput, where poultry manure @ 3 t ha^{-1} along with reduced rate of recommended dose of chemical fertilizers were applied (Table 1). The highest marginal benefit cost ratio (MBCR) was also recorded in the same combination. The storage behavior of sweet potato at ambient temperature will be presented in later. The maximum nutrient availability was found in T_3 (Table 2).

Table 1. Interaction effect of organic manure and inorganic fertilizers on the yield attribute and yield of sweet potato

Location	Treat	Vine length 60 DAP (cm)	Vine length 90 DAP (cm)	Vine length 120 DAP (cm)	Root length (cm)	Root diameter (cm)	Root hill^{-1} (no.)	Root wt. hill^{-1} (kg)	Root yield (t ha^{-1})
Joydebpur	T1	40.0 f	69.8	86.8 c-e	11.1	3.00	4.40	0.32 gh	15.0
	T2	50.0 b-e	91.7	139.0 a	13.3	4.37	5.59	0.48 bc	21.4
	T3	56.8 ab	114.0	145.0 a	15.8	4.71	6.60	0.58 a	23.5
	T4	52.1 a-e	105.0	141.5 a	14.0	4.40	5.80	0.56 a	22.0
	T5	56.2 a-c	111.0	142.0 a	15.0	4.43	6.30	0.53 ab	23.0
	T6	48.0 de	89.0	120.0 b	12.4	3.54	5.00	0.36 e-g	19.0
Bogra	T1	24.5 g	31.6	75.3 e	10.8	2.85	3.25	0.27 h	10.0
	T2	47.9 de	57.1	88.4 cd	13.4	3.70	4.35	0.35 fg	19.4
	T3	55.1 a-d	66.7	95.4 c	14.5	4.05	5.65	0.45 cd	22.8
	T4	48.7 c-e	61.3	94.6 c	14.3	3.96	5.19	0.41 de	21.8
	T5	58.8 a	60.7	90.5 cd	14.1	3.90	4.49	0.38 ef	20.6
	T6	45.5 ef	48.2	80.6 de	12.0	3.27	3.58	0.32 gh	18.0
	CV (%)	9.13	7.16	6.61	6.51	9.10	11.5	8.02	10.8

Table 2. Effect of INM on post-harvest soil properties

Treat	pH	OM (%)	Total-N (%)	Available K (meq/ 100g soil)	Available P (ppm)	Available S (ppm)
T1	6.3	1.00	0.064	0.08	18	9
T2	6.2	1.19	0.088	0.11	25	14
T3	6.6	1.25	0.10	0.11	27	15
T4	6.5	1.30	0.099	0.09	25	14
T5	6.2	1.19	0.088	0.11	26	14
T6	6.3	1.10	0.075	0.08	27	9
Initial value	6.4	1.20	0.090	0.09	20	10

Pest Management

Disease Management

Evaluation of Sweet Potato Varieties /Germplasms for Resistance to Virus Diseases

An experiment was conducted to screen the sweet potato lines against different virus diseases in 2015-16 cropping season at TCRC, Gazipur. Twenty four sweet potatoes germplasm were evaluated including three check varieties (BARI SP-11, BARI SP-12 and BARI SP-13). In respect of lower virus infection and higher yield, H2.2/09 was found to be the best line among the germplasms.

Insect Management

Development of effective integrated management package of sweet potato weevil

The experiment was conducted to evaluate the effect of IPM management package in controlling sweet potato weevil during 2015- 16 at Gazipur. Among the treatments, the lowest percent of tuber damage by weight (4.88%) and maximum yield (23.81t/h) was found in pheromone + Earthing-up three times + Carbofuran 5G (T_5) treated plots which differed statistically from other treatments. In case of the lowest mean grade crown and tuber damage recorded in pheromone + Earthing-up three times + Carbofuran 5G (T_5) treated plots. The population build-up of weevil population increase 247.11 in crown in the control over treatments. On the other hand, in tuber it was increased 408.64 percent in the control over treatment. Generally weevil population is higher in tuber than crown. Weevil infestation in relation to tuber size and maturity studied revealed that the infestation starts from the initiation of tuberisation in the control. Infestation were more in mature big tubers indicate the weevil incidence start vary early in the control plot. The weevil catch was significantly and positively correlated with weekly average rainfall and temperatures respectively. Based on all parameters, treatment T_5 (Pheromone trap + Earthing up three times + Carbofuran 5G) showed best result in controlling sweet potato weevil throughout the crop season eco-friendly, effectively and economically. The second best treatment was T_3 (pheromone trap + Earthing up 3 times). In general, with the increase of tuber size, weevil infestation increases. Weevil population was higher in tuber than crown.

Aroids

Varietal Improvement

Regional yield trial of upland taro (*Colocasia esculenta* var. *antiquorum*) lines

Three genotypes of Mukhikachu (*C. esculenta*), MK 129, MK 131, MK 176 along with a BARI released variety Bilashi as check were evaluated under regional yield trial. The combined effect between location and genotypes was statistically significant. The highest yield was obtained from MK 176 (37.96 t/ha). MK 176 also gave the highest yield in Gaziput (35.37 t/ha) followed by Jamalpur (34.26 t/ha). The highest yield was obtained from check Bilashi (29.44 t/ha) at Jessore.

Advanced yield trial of lowland taro (*Colocasia esculenta* var. *esculenta*) lines

Three genotypes of lowland taro (Panikachu) (*C. esculenta* var. *esculenta*), PK 119, PK 109, PK 134, and BARI Panikachu 1 (Latiraj) were selected as check and evaluated under regional yield trial. PK 109 line gave the highest yield among the interaction of varieties and locations which was 26.84 t/ha which was statistically similar with PK 134. But Panikachu line PK 134 performed best among the experimented areas in respect of stolon production in all the locations. The production of stolon ranged from 24.28 to 26.36 t/ha in different locations. The rhizome yield of the line PK 134 (55.91 t/ha) was the highest among the locations and varieties at Gaziput condition.

Collection and evaluation of aroids and other minor tuber crops germplasm

Thirty four planting materials of six crops from 12 locations of Bangladesh were collected during 2015-16. The corms of elephant foot yam, cormels of upland taro (Mukhikachu), suckers of lowland taro (Panikachu), bulbils of yams and roots of cassava was collected from the different parts of home and abroad. Among the collected 34 germplasms, 21 were upland taro, 2 lowland taro, 2 giant taro and 3 cocoyam, 3 cassava and 9 Yams. These materials were maintained in TCRC field at Gaziput.

Cultural Practices

Crop Nutrition

Development of fertilizer recommendation for Paniikach (C*olocasia esculenta* L.)

Organic manure and chemical fertilizers were tested at TCRC, Gaziput and TCRSC, Bogra during January to September 2015 for sustainable aquatic taro production and to develop a suitable fertilizer package and to investigate the post-harvest properties of soil. There were six treatments - T_1 (100% RDF), T_2 (120% RDF), T_3 (TCRC Recommended dose), T_4 (80% RDF + 3 t PM ha^{-1}), T_5 (Farmer's practice) and T_6 (Control, native nutrient). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The stolon and rhizome yields were significantly influenced by the nutrient management. The highest stolon (38.1 t ha^{-1}) and rhizome (24.2 t ha^{-1}) yields were found in T_5 ($N_{82}P_{65}K_{82}$ kg ha^{-1} + CD 16 t ha^{-1}) where chemical fertilizers were applied in three splits and cowdung was incorporated in four splits (Table 1). The nutrient availability was also increased in this combination. This is the first year trial and need to repeat to verify the result.

Table 1. Interaction effects of fertilizer and location on the yield attributes and yields of Panikachu

	Treat	Plant height (cm)	Length of biggest leaf (cm)	Width of biggest leaf (cm)	Stolon length (cm)	Stolon breadth (cm)	Stolon/ plant (no.)	Wt. of stolon/ plant (g)	Stolon yield (t/ ha)	Rhizome yield (t/ ha)
Bogra	T1	130	35.6	23.3 a	76.5	1.45 cd	26.0 bc	782.0 b	29.0 bc	18.4 bc
	T2	130.7	36.1	22.8 a	74.3	1.37 de	24.5 c	765.0 b	28.3 c	17.9 b-d
	T3	124.3	34.4	21.9 a	71.4	1.32 e	24.4 c	713.0 b	29.7 bc	16.7 cd
	T4	131.9	35.9	24.0 a	77.5	1.58 ab	28.3 ab	1006 a	31.8 b	20.1 b
	T5	132.5	36.6	24.2 a	78.4	1.67 a	29.7 a	1030 a	38.1 a	24.2 a
	T6	91.5	29.2	13.5 d	60.2	1.02 f	15.7 de	319.0 fg	11.6 gh	7.47 f
Joydebpur	T1	88.0	26.0	18.0 b	58.2	1.44 cd	16.7 de	495.0 cd	16.4 ef	11.5 e
	T2	89.0	26.4	18.4 b	60.0	1.45 cd	17.7 de	356.0 e-g	17.5 de	12.0 e
	T3	80.5	25.6	17.5 bc	55.0	1.40 c-e	15.6 de	460.0 c-e	15.6 ef	9.70 ef
	T4	77.5	24.0	16.8 bc	53.0	1.35 de	15.0 e	420.0 d-f	14.3 fg	9.00 ef
	T5	92.6	26.9	18.8 b	66.0	1.50 bc	18.8 d	550.0 c	19.8 d	15.2 de
	T6	60.0	20.0	15.0 cd	45.0	1.00 f	9.50 f	276.0 g	10.0 h	7.00 f
	CV(%)	6.10	7.02	8.40	11.7	5.20	10.2	12.0	7.75	12.9

Figures in column followed by same letter(s) or without letter do not differ significantly each other at 5% level.

Effect of nutrient management on the growth and yield of newly released Panikachu variety

The experiment was conducted at TCRSC, Bogra and RARS, Jamalpur during March to November 2015 to update and optimize the fertilizer package of newly released panikachu, to maximize the yield and quality and to observe the post-harvest soil properties. There were thirteen treatments - T_1 ($N_0P_{45}K_{200}$ kg ha^{-1}), T_2 ($N_{150}P_{45}K_{200}$ kg ha^{-1}), T_3 ($N_{200}P_{45}K_{200}$ kg ha^{-1}), T_4 ($N_{250}P_{45}K_{200}$ kg ha^{-1}), T_5

($N_{300}P_{45}K_{200}$ kg ha^{-1}), T_6 ($N_{200}P_0K_{200}$ kg ha^{-1}), T_7 ($N_{200}P_{30}K_{200}$ kg ha^{-1}), T_8 ($N_{200}P_{60}K_{200}$ kg ha^{-1}), T_9 ($N_{200}P_{45}K_0$ kg ha^{-1}), T_{10} ($N_{200}P_{45}K_{150}$ kg ha^{-1}), T_{11} ($N_{200}P_{45}K_{250}$ kg ha^{-1}), T_{12} ($N_{273}P_{30}K_{75}$ kg ha^{-1} + CD 16 t ha^{-1}, Farmer's Practice), T_{13} ($N_{161}P_{36}K_{125}$ kg ha^{-1} + CD 5 t ha^{-1}, TCRC recommendation). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The balanced fertilizer and optimum dose play an important role to produce rhizome and stolon of BARI Panikachu-5. The highest rhizome yield was found in T_7 ($N_{200}P_{30}K_{200}$ $kgha^{-1}$) which was statistically identical to T_{12} ($N_{273}P_{30}K_{72}$ $kgha^{-1}$ + CD 16 tha^{-1}) at Jamalpur. The maximum stolon yield was recorded in T_{11} ($N_{200}P_{45}K_{250}$ $kgha^{-1}$) which was closely followed by T_{12} ($N_{273}P_{30}K_{75}$ kg ha^{-1} + CD 16 t ha^{-1}, Farmer's Practice). This is the first year findings and need to verify the result in next year.

Assessment of heavy metal uptake and translocation in wild upland taro (*Colocasia esculenta*) for phytoremediation of metal contaminated soil

Heavy metal pollution in soil is a widespread global problem and also a major environmental concern. This soil contaminant needs to be cleaned up for safe environment. An experiment was conducted to evaluate the potential of *Colocasia esculenta* as a phytoremediator to absorb heavy metals from contaminated soils. *C. esculenta* seedlings were planted on seven levels of cadmium (T_0 = Control, soil, T_1 = 25 ppm Cd, T_2 = 50 ppm Cd, T_3 = 75 ppm Cd, T_4 = 100 ppm Cd, T_5 = 125 ppm Cd and T_6 = 150 ppm Cd) and same levels of arsenic (As). In case of As, the highest growth performance such as plant height, leaf length, leaf breadth, fresh weight of leaf, petiole and corm was found in uncontaminated soil. The lowest growth performance was in the highest level of As. In case of Cd, the highest growth performance was recorded in T_4 (100 ppm Cd) and T_5 (125 ppm Cd). The lowest growth performance was in the uncontaminated soil. The highest N, P, K and S availability was found in T_4, T_3, T_4 and T_6, respectively while the highest N, P, K and S availability was found in 25 ppm As and uncontaminated soil, respectively in As contaminated soil. In As, nutrient absorption by the plant was reduced in the highest contaminated soil whereas, highest Cd contamination did not hamper nutrient absorption.

Integrated nutrient management for newly released Mukhikachu

Newly released Mukhikachu (BARI Mukhikachu-2) was evaluated under integrated nutrient management at TCRC, BARI, Gaziput and TCRSC, Bogra during 2015 to develop a suitable fertilizer package to study the post-harvest properties of soil. There were eight treatments T1 (Control), T2 (100% RD), T3 (125% RDF), T4 (PM @3t ha^{-1}+ Rest chemical fertilizer), T5 (CD @ 6 t ha^{-1}+ Rest chemical fertilizer), T6 (80% RDF + 20% from PM), T7 (80% RDF + 20% from CD), T8 (Farmer's practice). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Yield of mukhikachu was significantly ($p \leq 0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The highest cormel (34.9 t ha^{-1}) and corm (8.70 t ha^{-1}) yields were found in 125% RDF which was closely followed by T4 (PM @3t ha^{-1}+ Rest chemical fertilizer) at Bogra. The post-harvest soil data will be presented after receiving the analytical report. This is the first year findings and the experiment will be repeated to verify the result.

Pest Management

Disease Management

Screening of new fungicides against leaf blight of Panikachu

A total of eight new fungicides including the check 'Dithane M 45' were tested against leaf blight of Panikachu at Gaziput during kharif season in 2014-15. The fungicide namely Monjil 72 WP followed by Azotix 80 WP showed the highest reduction of disease (77.63%) based on the percentage of disease incidence and foliar infection and gave the highest yield compared to other fungicides.

Insect Management

Efficacy of different management approach against red spider mite (*Tetranychus urticae*) of Panikachu

Pest status and incidence of red spider mite of Panikachu was studied and five different treatments were tested against this pest during kharif season 2015. Incidence of mite population 2 cm^2 per leaf per plant and population appeared during 3rd week of March. Then the population increased drastically up to 4th week of April. At that week the population counted as the highest value as 52.47 per 2cm^2/leaf/plant, when the weekly average temperature, relative humidity and rainfall were 34.1^o C, 72 % and 10 mm respectively. Correlation between mite infestations with important weather parameters showed that mite population was positive correlation with weekly average temperature; weekly total rainfall was negative correlation and also negative correlation with weekly average relative humidity. The mite population showed a tendency to increase with the increase of high temperature and low relative humidity. Also found that heavy rainfall is the factor which contributes to the low population of spider mite. In case of population density, the most densely mite population was found in older leaf (59.09%) followed by young leaf (29.54%) and newly emerged leaf (11.36%). Among the five treatments, the lowest percent of infested leaf per plant was recorded in Vertimec (28.50%) and followed by Soap powder + alternate spray of Neem seed extract treated plots. The height percent of infested leaf per plant found in control plot (92.38%) and it was significantly different from all other treatments. However, the reduction of mite population over control was maximum (70.91%) in T_4 (Vertimec 1.8 EC) treatment and closely followed by Soap powder+ alternate spray of Neem seed extract (63.71%) and they were significantly different from all other treatments. The yield of stolon was the highest in Vertimec 1.8 EC treated plots (17.00 t /h).

Among the six treatments based on their efficacy levels and yield T_4 (Vertimec 018 EC) would be the most effective control measure against red spider of panikachu. So, considering benefit cost ratio T_2 (Soap powder + alternate spray of Neem seed extract) could also be suggested.

Monitoring, documentation and damage severity of insect pests along with their natural enemies of minor tuber crops

A field study was conducted to monitoring the present status of insect pest and natural enemy of different minor tuber crops during 2015 -16 at different locations. Mealy bug was only observed at maturity stage at Gazipur and this insect population was 8.35 per 5 leaves. Any harmful insect was not found at Bandarban and Rangamati area at seedling or vegetative stage of cassava. But grass hopper was appeared on cassava plant at Bandarban and Rangamati. The mean number of grass hoper per plant was 0.02 and 0.01at Bandarban and Rangamati respectively. Three types of harmful insects and three types of natural enemies were observed in Jicama (Yam bean) at different growth stage at Gazipur location. The harmful insect bug was found in both seedling, vegetative and maturity stage and the mean number of bug was 0.12, 1.18 and 2.32 respectively. Moreover, red mite and weevil were also found only at maturity stage of Yam bean and the mean population was 12.49/2cm^2/leaf and 0.01/plant respectively. On the other hand, natural enemy per plant such as -bumble bee, wasp and black ant were only found at maturity stage and their mean population was 0.6, 1.00 and 9.64 per plant respectively. There was no harmful insect and natural enemy found at Jessore and Gazipur location both yam and Elephant foot yam.

3 PULSE CROPS

Overview Research Progress of Pulses Research Centre during 2015-16

A total of eighty one research program executed by different divisions at pulses research centre during 2015-16. Fifty two experiments conducted by varietal development project. In soil and crop management project thirteen programs carried out at different locations. Sixteen experiments implemented by pathology and insect division.

Blackgram: Hybridization and advancement of F_1 and F_3 generations of blackgram was done during kharif-II at Ishurdi. A total 189 seeds have been collected from 15 crosses. From F_2 progenies/F_3 generations, two pods were collected from each of the harvested plant of each progeny and bulked following double pod descent method for the next year trial. Ten lines along with check variety BARI Mash-3 were evaluated in observation yield trial. Entries viz. BBLX-08010-4-1, 9007, BBLX-08010-2-1, Ishurdi local and BBLX-08008-2-1 performed well in comparison to check varieties. So, five lines are selected to evaluation the next year for PYT. The lines BBLX-06002-10, BBLX-07002-5 and 86337 gave good seed yield which were selected to evaluate in the next season in PVS in farmers fields. Genotypes *viz.*, BBLX-06002-10, BBLX-07002-5 and 86337 performed better over different blackgram growing areas and three genotypes showed better performance in High Barind Tract. Eight entries of blackgram to evaluated at Pulses Research Centre, Ishurdi, Pabna. Among the entries highest yield was obtained from BG- 3 followed by BG-2 and BG-4.

Lentil : Hybridization and advancement of F_1 to F_5 generations were conducted during rabi 2015-16 at PRC, Ishurdi, Pabna. Six parents were used and a total of 291 successful crossed seeds were collected from fifteen cross combinations.F_1s were grown from 15 crosses to generate segregating F_2 population. Two pods were collected from each of the harvested plant of each progeny and bulked following double pod descent method for the next year trial from F_2, F_3 and F_4 generations considering higher yield and other desirable traits with resistance against stemphylium blight. A total of fifteen lines were selected from five accessions on the basis of yield, disease resistance and other desirable characters. Each of the selected lines will be treated as family and will be grown at observation trial in the next year. In the observation trial, BLX-10001-1, BLX-10001-3, BLX-10002-12 and BLX-10002-15 were selected to evaluate in PYT in the next rabi season. Four genotypes could be selected through PYT for testing in the regional yield trail . The two genotypes were also found resistant reaction to stemphylium blight. In regional yield trial, considering all the stability parameters, yield contributing characters and disease reaction the genotypes BLX-06004-2, BLX01013-1 and BLX-06004-12might be selected through PVS trial in farmer's field to obtain farmers' opinion. In the screening of advanced lines under late and optimum sown condition, BARI Masur-8, LRIL 22-205, BLX06004-2, BARI Masur-3 and BARI Lentil 5 are suitable for late sowing after harvesting of aman rice. In regional trials in SAARC countries the three entries was found better in respect of yield and related attributes. Six promising lines were identified for higher seed yield with tolerance to stemphylium blight and rust. In station trial, 9 entries were evaluated along with one check under relay condition. Six collaborative international trials between BARI and ICARDA were conducted at Pulses Research Centre, Ishurdi, Pabna. Among different international trial four entries from F_4, 2 entries from F_5, 5 from micronutrient trial, 9 from early and drought and 22 from international screening nursery were selected on the basis of earliness and other desirable characters. All these entries will be brought under trial in the next year for further evaluation. Genetic marker-assisted selection may provide opportunities for rapid and efficient selection of *Sclerotium rolfsii*-suppressing *Bacillus* strains from lentil rhizosphere and the development of microbial bio-pesticides. Screening of lentil lines against stemphylium blight revealed that the highest frequency of resistance to SB was found in LT-07. Efficacy of different fungicide for stemphylum blight disease in lentil demonstrated that the lowest severity was observed in Rovral 50WP (Iprodione) (0.2%). Therefore, the micronutrient management practices of T_5= $Zn_{2.0}B_{1.5}$ may be considered as economically sound and suitable dose for lentil yield maximization in calcareous and terrace soils of Bangladesh. Another experiment conducted on nutrient management, the application of 60 kg or 50 kg K ha^{-1}may be considered as economically sound and suitable dose for lentil yield maximization in terrace and calcareous soils of Bangladesh. This experiment carried out to evaluate the effect of growth and yield parameters and to determine the optimum rate of nutrients of lentil. The effect of fertilizer combinations on the plant growth parameters was not significant but yield characters varied significantly.

The seed rates 70 kg/ha produced the highest seed yield of short duration lentil. The light irrigation with 20 kg/ha P produced the highest seed yield. Application of Se reduced arsenic contains of seed and straw of BARI Masur-3 and BARI Masur-6.The implementation of NT and SP had no effects on seed yield but the straw yield and harvest index (%) of first crop lentil in the rotation increased in strip planting than conventional tillage.

Chickpea: In the hybridization, a total of 117 successful crossed seeds were collected from fifteen cross combinations. Advancement of generations was done and seeds and plants of different generations were selected for growing respective next generation. F1s were grown from 15 crosses to generate segregating F_2 population. From F_4 generation 11-17 plants were selected from each progeny and harvested separately which will be grown in F_5 generation in the next season considering higher yield and other desirable traits with resistance against BGM. In observation trial, five entries BCX 01008-8, BCX 01008-4, BCX 01008-3, ICCV 07105 and ICCX 060157-3 are selected to evaluated on the basis of higher yield, higher pods per plant and bold seed size were selected for PYT in the next rabi season. Six entries were selected for further evaluation from preliminary yield trial. From regional yield trial twoEntries BCX 08009-9 and BCX 08001-3 might be selected to evaluate in the next rabi season in PVS trial in the farmers field for their opinion. The entries BCX06004-10 and BCX06001-11 could be tested in the next year. Screening of chickpea germplasm resistant to botrytis gray moldshowed that none of the test entries were complete resistant to BGM whereas BCX 09010-2, BCX 09015-7, BCX 09010-6, BCX 08010-9, BCX 08001-3, BCX 06001-11, ICCV-98801 showed moderately resistant reaction to the disease. Efficacy of fungicides in controlling botrytis gray mold of chickpeatrial showed that Secure 600WG (Fenamidone+Mancozeb), Knowin 500SC (Carbendazim) treated plots performed lowest diseases score (both 2.33) against BGM.

Grasspea: Out of 9 entries along with one check variety evaluated in Preliminary yield trial, three entries *viz.*, BKX 003-1, BKX-0002-4 and SEL-1348 showed better performance at Ishurdi and Madaripur location. Genotypes Sel-1348, Sirajgonj local and BKX-0003-1 are selected for next year trail for confirmation under relay condition three genotypes Sel-1348, Sirajgonj local and BKX-0003-1 are selected for next year trail. In the grasspea international F_5 nursery, twelve entries were evaluated. IT08KIFLA1900XWaise, IFLA288XIFLA299, BARI-K2XK209 and IFLA3026XBARI-K2 were selected for yield and earliness. In another international low B- ODAP trail IFLA1419, IFLA1826 IFLA2341, IFLA119, IFLA118, IFLA2781, IFLA2750, bio520and IFLA3001, IFLA119, IFLA118, IFLA1439 were selected for yield and earliness for further evaluation in breeding trials. In early type international nursery trial, IFLA2998, IFLA2282, IFLA2924, IFLA2158, IFLA2968, IFLA2974, IFLA159, IFLA2765, IFLA220, IFLA2460, IFLA2736, IFLA1720, IFLA2395 and IFLA1522, IFLA2475 and IFLA2765 were selected for yield and earliness to further trail will be needed. The highest seed yield of khesari was found in Sirajgonj local than BARI Khesari-2 and BARI Khesari-1.The application of Zn @ 2 kg/ha along with B @1.5-2 kg/ha are suitable dose for better lentil yield. The K dose @ 50-60 kg ha^{-1}with the blanket dose of $N_{15}P_{20}S_{10}Zn_2B_{1.5}$ kg ha^{-1} are suitable for lentil cultivation in terrace and calcareous soils of Bangladesh. The FRG 2012, 75% FRG +25% CD and 75% FRG + 25% PM are effective in increasing yield of lentil. BARI Khesari-3 performed better in increasing yield than BKX 002-3 and Serajgonj local in saline soil.

Fieldpea: Hybridization of pea was conducted to obtain genotypes having desired gene combinations during rabi 2015-16 at PRC, Ishurdi, Pabna. Five parents were used and a total of 158 successful crossed seeds were collected from fifteen cross combinations. Nine F_{1s} were confirmed from thirteen cross combination. Few short and long duration lines *viz.* BD 4142, Sekim local, Natore local-1 and Jhikorgacha local were identified having high yield potentiality with powdery mildew tolerance. Early-97 and Pea 88 showed stable performance under PVS trial as promising short duration genotypes. Few promising lines were identified for higher seed yield potential at Ishurdi location. The application of Zn @ 2 kg/ha and B @1.5-2 kg/ha are suitable dose for field pea cultivation in calcareous and terrace soils of Bangladesh.

Mungbean: In hybridization program on mungbean was conducted at PRC, Ishurdi, Pabna. Total 15 fresh crosses were made to generate variability and develop new plant types. A total of 472 successful crossed seeds were collected from 15 cross combinations. F_1s were grown from 15 crosses to generate segregating F_2 population. Two pods were collected from each of the harvested plant of each progeny and bulked following double pod descent method for the next year trial From F_2 and F_3 progenies. Eighty eight single plant selection (SPS) were made from F_4 generation considering higher yield and other desirable traits. From F_5 generation, a total of twenty eight lines were selected from six accessions on the basis of yield, disease resistance and other desirable characters. In the study of observation trial, five entries were selected for PYT in the next kharif-i season. Two genotypes was found better compare to other genotypes from preliminary yield trial which will be confirmed for further RYT trial. From regional yield trial four Entries BMX-08011-8, BMX-08011-2, BMx08011-2 and BMX08011-8 selected for PVS in the next year. In this study, quantitative trait locus (QTL) mapping in mungbean using an F_2 population of 142 lines derived from a cross between KPS-I (75-80 days) and BARImung- 6 (55-60 days). $F_{2:3}$ lines grown under field condition at Gazipur 2016. Single marker analysis suggested at least five loci controlling maturity. Composite interval mapping consistently identified four QTLs, qMAT1,qMAT2, qMAT3, qMAT6 and qMAT8, on linkage groups 1, 2, 3,6 and 8. These QTLs accounted for 7.54 to 18.83% variation depending on different linkage group.14 entries were evaluated along with one check entries *viz*., BMX-97024-13, Sukumar, IPM-02-03 and TMB 37are selected for different breeding trials in the next year. Ten entries of mungbean collected from Bangladesh, India, Nepal and Pakistan were evaluated at Pulses Research Centre, Ishurdi, Pabna. Among the entries highest yield was obtained from MB-06 followed by MB-03 and MB-08. Screening of mungbean lines resistant to YMV and CLS revealed that BD-6926, BD-6941, BMMP-201515, BMMP-201524, BMMP-201525 VC-6173, BMXK1-06006-4 and SM2-134 yielded lowest MYMV score (2.00) and resistant to CLS. Planting time and spray schedule on development of stemphylium blight of lentil trial showed that 5th November planting and spray schedule started at 60DAS with Rovral performed better for reducing Stemphylium blight disease severity(2.00) and increased seed yield (1485 kg/ha). Post-sowing whip super was effective in controlling weed of mungbean while provided the highest gross return and MBCR.

Cowpea: Screening of cowpea genotypes in the southern region, the three cowpea entries CPS-13, CPS-6 and CPS-12 should be tested in the next season for making final recommendation. This experiment carried out to evaluate the effect of growth and yield parameters and to determine the optimum rate of nutrients of cowpea. The highest seed yield (1570kg/ha) was produced in treatment T_5 (20-20-20-10-2-1.5 NPKSZnB kg/ha).

Blackgram (Kharif-II)

Varietal Improvement

Hybridization of blackgram

Hybridization of blackgram was conducted to obtain genotypes having desired gene combinations during Kharif II 2015 at Pulses Research Centre, Ishurdi, Pabna. Six parents were used and a total of 189 successful crossed seeds were collected from fifteen cross combinations.

Growing F_3 generation of blackgram

To advance the generation and to attain more homozygosity F_3 generation was grown during kharif -II, 2015 at Pulses Research Centre, Ishurdi, Pabna. Eleven F_2s were bulked for advancement of the generation and retention of wide variability.

Observation trial of blackgram

Ten lines along with check variety BARI Mash-3 were evaluated at Pulses Research Centre, Ishurdi, Pabna. No significant difference was observed for days to maturity, pods per plant and seeds per pod among the genotypes. Maximum days to flower (45 days) required for Ishurdi local and the minimum for 9007. The genotype BBLX-08010-4-1was matured earlier (67 days) followed by BBLX-08010-2-1and BBLX-0806-7-1(68 days) and later maturity was recorded from genotypes Ishurdi local and Local check (71 days). The maximum plant height was observed from the genotypes Local check and minimum was observed from the genotypes BBLX-08006-8-1. All the entries showed moderate resistance to Blackgram Yellow Mosaic Virus (BYMV). Highest average 100 seed weight (4.49 g) was found in BARI mash-3 followed by BBLX-08010-4-1 and BBLX-08010-2-1. Entries BBLX-08010-4-1 showed maximum yield (1285 kg/ha) and lowest yield was obtained from BBLX-08006-8-1 (797 kg/ha). So, considering yield and yield contributing characteristics, five genotypes BBLX-08010-4-1, 9007, BBLX-08010-2-1, Ishurdi local and BBLX-08008-2-1 were selected for PYT in the next year.

Regional yield trial of blackgram

The experiment was conducted at Pulses Research Centre, Ishurdi, Pabna, Jessore, Jamalpur, Madaripur, Rajshahi and Gazipur during kharif II, 2015 to find out desirable lines of Blackgram. Six Blackgram lines BBLX-07002-1, BBLX-07002-5, BBLX-06002-10, BBLX-02005-1 and 86337 were used in the experiment with BARI Mash-3 as a check variety. The genotypes 86337 gave highest average yield (1206 kg/ha) among the genotypes followed by BBLX-06002-10(1089 kg/ha) and BBLX-07002-5 (1076 kg/ha). It also produced highest seed yield in Joydebpur (1334 kg/ha). The lines 86337, BBLX-06002-10, BBLX-07002-5 and 86337 gave good seed yield which were selected to evaluate in the next season in PVS at farmers fields.

Field screening for adaptability of blackgram genotypes in high barind tract

The trial was carried out at the farmer’s field of FSRD site, Kadamshahar, Godagari, Rajshahi during kharif-2 season, 2015 to evaluate the high yielding blackgram genotypes in drought prone area. Seven genotypes/varieties of blackgram viz. BBLX-08010-2-1, BBLX-08010-4-1, BBLX-02005-1, BBLX-07002-5, BBLX-07002-1, local and BARI Mash-3 were tested in the farmer’s field. Among the tested genotypes/varieties BARI Mash-3 gave the maximum seed yield (1.40 t ha^{-1}) and local variety gave minimum seed yield (0.99 t ha^{-1}).

Regional trials on blackgram in SAARC member countries

Eight entries of blackgram collected from Bangladesh, India, Nepal and Pakistan were evaluated at Pulses Research Centre, Ishurdi, Pabna during kharif II 2015. Significant differences among the genotypes were observed except seeds per pod. Among the entries of BG4 was found compare to others. The highest pods/plant was obtained from BG- 3 followed by BG-2 and lowest was from BG-8. The entries highest yield was obtained from BG- 3 followed by BG-2 and BG-4.

Lentil

Varietal Improvement

Hybridization of lentil

Hybridization of lentil was conducted to obtain genotypes with desired gene combinations during rabi, 2015-16 at Pulses Research Centre, Ishurdi, Pabna. Six parents were used and a total of 291 successful crossed seeds were collected from fifteen cross combinations.

Confirmation of F_1 of lentil

Confirmation is essential to ensure F_1s between the parents. Fifteen F_1s obtained from rabi 2014-15 were grown along with their parents at Pulses Research Centre, Ishurdi, Pabna. Finally, fifteen F_1s were confirmed, harvested separately and will be grown in the next year.

Growing F_2 generation of lentil

Maximum segregation is attained in F_2 generation and with a view to select appropriate and desired combinations twenty F_2s were grown along with check at Pulses Research Centre, Ishurdi, Pabna. The whole population was bulked for the retention of wide variability which will be grown in the next year.

Growing F_3 generation of lentil

To advance the generation from F_3 to F_4 and with a view to select appropriate and desired combinations six F_3s were grown along with check at Pulses Research Centre, Ishurdi, Pabna. The whole population was bulked for the retention of wide variability which will be grown in the next year.

Growing F_4 generation of lentil

To advance the generation from F_4 to F_5 and with a view to select appropriate and desired combinations twelve F_4s were grown along with check at Pulses Research Centre, Ishurdi, Pabna. The whole population was bulked for the retention of wide variability which will be grown in the next year.

Growing F_5 generation of lentil

Genetic combination turns to more homozygosity in F_5 and for this reason selection of family is done in this generation. To select appropriate and desired combinations five F_5s were grown along with check at Pulses Research Centre, Ishurdi, Pabna. Finally fifteen lines were selected which will be grown in the next year at observation trial.

Observation trial of lentil

Fourteen families selected from last year's F_5 families were grown with check varieties BARI Masur-6 and BARI Masur-7 in rabi, 2015-16 at Pulses Research Centre, Ishurdi, Pabna. Highest pods per plant were found in BARI Masur-6 and lowest in BLX-10005-6. Bold size seeds (3.09 g) were obtained from BLX-10001-1. The highest seed yield was obtained from BARI Masur-7 followed by BARI Masur-6. Based on overall performance genotypes like BLX-10001-1, BLX-10001-3, BLX-10002-12 and BLX-10002-15 were selected for further evaluation.

Preliminary yield trial of lentil

Significant variation was observed for days to flower, days to maturity, pods per plant, 100 seed weight and yield in kg per hectare. The lowest days to maturity was recorded in LRIL 22-70. Large seed size was recorded in BLX 04005-9. Considering yield performances in GGEbiplot analysis BLX09015, BLX 04005-9, LRIL22-70 and LRIL22-133 found better compare to others.

Participatory varietal selection of lentil

The experiment was conducted at five locations in the farmer's field during Rabi 2015-16 to find out desirable lines through farmer participation. The genotype BLX-01013-1 was earlier compare to others. Considering pod/plant and 100-seeds weight, the entries BLX-06004-2, and BLX-06004-12 were found better. GGE biplot analysis revealed that the genotypes BLX-06004-12 showed stable performances over the tested locations.

Screening advanced lines/varieties of lentil under late and optimum sown condition

Significant difference was observed in yield and yield related traits in two different sowing dates. First sowing (07 Nov.) produced higher yields compared to late sowing in 26th November. Considering sowing dates highest yield was found in BARI Masur-8 and LRIL 22-205 in both sowing dates, followed by BLX06004-2. Apart from these the early lines LRIL 22-133 and LRIL 22-70 showed better yield at late sown condition. The rest of the variety/genotypes had no remarkable yield difference between two dates of sowing.

Regional trials on lentil in SAARC member countries

Twelve entries of lentil collected from Bangladesh, India, Nepal and Pakistan were evaluated at Pulses Research Centre,Ishurdi, Pabna during rabi 2015-16. The trial was laid out in a RCB design with 3 replications with a view to select promising genotypes for each of the SAARC member country. Significant differences among the genotypes were observed in all the yield contributing characters. Highest pods/plant was obtained from LT-01 followed by LT-04 and lowest was obtained from LT-02. Bold seeded entry was LT-02 followed by LT-04. Among the entries highest yield was obtained from LT-03 followed by LT-02, LT-05, LT-07 and LT-11. So, these five entries are selected to evaluate in the next year.

Evaluation of lentil germplasm collected from West Bengal

Fourteen entries of lentil collected from west Bengal, India with two native varieties BARI Masur-6 and BARI Masur-7 were evaluated at Pulses Research Centre,Ishurdi, Pabna during rabi 2015-16 and laid out in a RCB design with 2 replications with a view to select promising genotypes. Significant differences among the genotypes were observed in all the yield contributing characters. Subhendu was the tallest plant followed by RL-12-179 and the entry BARI Masur-7 was the dwarf among the entries. Bold seeded entry was RL-12-175 and small seeded entry was RL-12-179. Almost all the entries showed moderate resistance to stemphylium blight. Among the entries the highest yield was obtained from DPL-62 followed by RL-12-178 and Maitree.

Screening of lentil germplasm under relay condition

Nine promising entries of lentil collected from PRC, Ishurdi, Pabna with BARI Masur-6 as check were tested at Pulses Research Centre,Ishurdi, Pabna during rabi 2015-16. The trial was laid out in a RCB design with 2 replications with a view to select suitable genotypes for relay with T. aman rice. Significant differences among the genotypes were observed in all the yield contributing characters. BLX-06004-2 was the tallest and LRIL 21-109 was the dwarf among the entries. Bold seeded entry was LRIL 21-109 and small seeded entry was BLX-01013-1. Among the entries the highest yield was obtained from BLX-01013-1 followed by BLX-06004-12 and BLX-06004-2. Considering all the attributes, three entries BLX-01013-1, BLX-06004-12 and BLX-06004-2 are selected to evaluate in the next year.

Evaluation of early lentil germplasm under different row orientation

Three promising early genotypes of lentil were evaluated under three different row orientation (15 cm, 20 cm and 25 cm, respectively) at Pulses Research Centre,Ishurdi, Pabna during rabi 2015-16. Among the three genotypes LRIL 21-109 was found better in respect of yield under 20m row spacing. Considering genotypes x row spacing LRIL21-109 showed better performance.

International trials of lentil

Six collaborative international trials between BARI and ICARDA were conducted at Pulses Research Centre, Ishurdi, Pabna during rabi, 2015-16. Most of the entries showed prolonged vegetative growth without any pod formation. Few plants produced a small number of pods. Among different international trial four entries from F_4, 2 entries from F_5, 5 from micronutrient trial, 9 from early and drought and 22 from international screening nursery were selected on the basis of earliness and other desirable characters. All these entries will be brought under trial in the next year for further evaluation.

Pest Management

Marker assisted selection of antifungal *Bacillus* species from lentil rhizosphere for biological control of foot rot disease of lentil

A marker-assisted approach was adopted at Pulses Research Centre, Ishurdi and Charles Sturt University, Australia to search for *Bacillus* spp. with potential as biocontrol agents against foot rot disease of lentil caused by *Sclerotiumrolfsii*. Bacterial strains were isolated from the rhizosphere of lentil and screened using multiplex PCR for the presence of surfactin, iturin A and bacillomycin D peptide synthetase biosynthetic genes where CS-42 was positively identified as *Bacillus cereus* using 16S rRNA gene sequencing. This strain was found to be effective in significantly inhibiting the growth of *S. rolfsiiinvitro* observed through scanning and transmission electron microscopy. Genetic marker-assisted selection may provide opportunities for rapid and efficient selection of *Sclerotiumrolfsii*-suppressing *Bacillus* strains and the development of microbial bio-pesticides.

Screening of lentil lines against stemphylum blight

The present screening was conducted at Pulses Research Centre, Ishurdi with 10 accessions based on previous trial for Stemphylium Blight (SB) resistance. These accessions were screened in natural field environments, to identify resistance sources for potential use in lentil breeding. Lentil variety BARI Masur-1 (susceptible) was used as checks with consistent results throughout the experiment. The highest frequency of resistance to SB was found in LT-07 (1) followed by BLX-06004-12 (1.6), BLX-06004-2 (2.3) and LR-9-25 (2.6). The highest yield (1080.3 kg/ha) was produced by the entry LT-07 which is statistically similar to the yield (1052.9 kg/ha) of the entries BLX-06004-2 and LR-9-25L. Upon further trial, these sources can potentially be used to develop new commercial cultivars with SB disease resistance.

Efficacy of different fungicide for stemphylum blight disease in lentil

The experiment was conducted at Pulses Research Centre, Ishurdi to find out the effective fungicides in controlling stemphylium blight of lentil. All the four fungicides showed significantly better performance over control. Stemphylium blight disease severity ranged from 0 to 5 in rating scale. The lowest severity was observed in combined treatment of Nativo (Tebuconazole 50%+ trifdoxystrobin 25%) and Folicur (Tebuconazole 0.5%), (0.3) sprayed plots and the highest severity (5) was recorded in untreated control plots. The highest yield (940.4 kg/ha) was obtained from combined treatment of Nativo and Folicur sprayed plots while the lowest (543.6 kg/ha) was in untreated control. Economic analysis revealed that the maximum profit (Tk. 22771/ha) was obtained from Folicur among the fungicides.

Screening of lentil lines against stemphylium blight under inoculated condition

A field experiment was carried out at Regional Pulses Research Station (RPRS), Madaripur to select resistant lines of lentil against stemphylium blight. Results revealed that one line namely BD-3806 gave lowest (resistant) stemphylium blight disease score (1.66). The highest stemphylium disease score (3.66) was observed in the line LRIL-22-70, LT-07. However, due to higher rainfall at flowering stage the lines infected with stemphylium disease resulting low yield of the tested lines. Among the 27 lines, BD-3853 gave highest yield (400 kg/ha) and the lowest was obtained by the line BD-3825 which was 258.30 kg/ha.

Effect of planting time and spray schedule on development of stemphylium blight of lentil

A field experiment was conducted at Regional Agricultural Research Station, Jessore. Four planting times were applied as main plot treatment such as MP1=25th October, MP2=5th November, MP3=15th November and MP4=25th November, 2015. On the other hand, four spray schedule were placed as subplot treatment in each main plot, as SP1=40 DAS, SP2=50 DAS, SP3=60 DAS and SP4=70 DAS. Among the treatments MP2, where planting date was 05 November 2015, and SP3, where the spray schedule started at 60 DAS showed better performance for reducing (2.00) Stemphylium blight disease severity and increasing yield (1485 kg/ha).

Standardization of spray schedule of two effective fungicides against stemphylium blight disease of lentil

The experiment was conducted at Regional Agriculture Research Station, Jessore to find out the effective fungicides and spray schedule in controlling Stemphylium blight of lentil. Five treatment such as, T1=Rovral, T2= Secure, T3= Alternate spray of Rovral and Secure, T4= Rovral + Secure (1:1) and T5= Control were applied form the first appearance of the disease at 10 days intervals. The lowest disease severity (2.00) was found from Rovral and alternate spray with Rovral and Secure. The highest seed yield (1472 kg/ha) was recorded in Rovral treated plots which was statistically similar to T3 (alternate spray with Rovral and Secure) treated plot (1455 kg/ha) and the lowest yield (735 kg/ha) was found from control plot.

Cultural Practices

Performance of short duration lentil lines under different sowing method with different seeding rates

A field experiment was conducted at PRC, Ishurdi and PRSS, BARI,Gazipur during rabi season of 2015-16 to find out the sowing method with optimum seed rate for short duration lentil lines for better crop growth and yield. There were two sowing methods- line sowing 20 cm apart and broadcast, and four seed rates like-50 kg/ha, 60 kg/ha, 70 kg/ha and 80 kg/h. It was laid out in a split-plot design with three replications where sowing methods were placed in the main-plot and seed rates were placed in the sub-plot. It was observed that between line and broadcast sowing there was no significant difference but slightly higher yield was obtained by line sowing for both the locations. Among the seed rates 70 kg/ha produced the highest significant seed yield and the lowest was obtained by 50 kg/ha for both the locations.

Crop nutrition

Effect of selenium on arsenic uptake in lentil at Ishurdi

A field experiment was conducted at farmers field of Kolerkandi village under IshurdiUpazila of Pabna district during rabi season of 2015-2016 to find out the effect of Selenium(Se) on arsenic uptake in lentil under arsenic prone area. There were two varieties BARI Masur-3 and BARI Masur-6 were tested under selenium application @ 1 gm m^{-2} area and control condition.It was laid out in a split-plot design with three replications where varieties were placed in the main-plot and selenium application levels were placed in the sub-plot. It was found that the initial soil i.e. before sowing, soils were contained 9.5-9.3 ppm arsenic but after experimentation, the soils contained 6.3 ppm and 5.7 ppm arsenic in the control and Se application @ 1 gm m^{-2} area plot,respectively which shown arsenic decreasing trend after experimentation for both the cases but decreasing rate is higher in the Se application plot. Similarly the arsenic contains of seed and straw of lentil decreasing rate is higher in the Se application plot's for both the varieties.

Response of lentil to zinc, boron and molyebdenum application

A study was conducted at the research field of Pulses Research Sub-Station, Gazipur and RARS, BARI, Jessore during 2015-16 to estimate the effective doses of micronutrients (Zn, B and Mo) for lentil yield maximization in Bangladesh. There were 8 treatments viz. T_1 = Control, T_2 = Zn 2.0 kg ha^{-1}, T_3= B 1.5 kg ha^{-1}, T_4= Mo 1.o kg ha^{-1}, T_5= $Zn_{2.0}B_{1.5}$, T_6= $Zn_{2.0}Mo_{1.0}$, T_7= $B_{1.5}Mo_{1.0}$ and T_8= $Zn_{2.0}B_{1.5}Mo_{1.0}$ along with the blanket dose of $N_{15}P_{20}K_{30}S_{10}$ kg ha^{-1}. The experiment was designed randomized complete block with three replications. The seed yields of lentil ranged from 822-1256 kg ha^{-1} at Gazipur and 987-1667 kg ha^{-1} at Jessore, respectively. The highest lentil seed yield was obtained from the treatment T_5 at Gazipur and at Jessore it was highest in T_8 treatment. The highest net return was counted from T_5 treatment at Gazipur and at Jessore it was highest in T_8 treatment. The highest benefit cost ratio 2.90 and 3.43 were counted from the treatment T_5 at Gazipur and Jessore, respectively. Therefore, the micronutrient management practices of T_5= $Zn_{2.0}B_{1.5}$ may be considered as economically viable dose for lentil yield maximization in calcareous and terrace soils of Bangladesh.

Influence of different levels of potassium on nodulation, quality, yield and nutrients uptake of lentil

An experiment was conducted in the research field of Pulses Research Sub-Station, BARI, Gazipur and RARS, Jessore during Rabi 2015-16 to estimate the suitable doses of potassium for nodulation, quality and yield maximization of lentil. There were 5 treatments viz. T_1 = Control, T_2 = K 30 kg ha^{-1}, T_3= K 40 kg ha^{-1}, T_4= K 50 kg ha^{-1} and T_5= K 60 kg ha^{-1} along with the blanket dose of $N_{15}P_{20}S_{10}Zn_2B_{1.5}$ kg ha^{-1}. The average yields of lentil ranged from 961-1358 kg ha^{-1}. The highest lentil yield 1015 kg ha^{-1} at Gazipur and 1701 kg ha^{-1} at Jessore were obtained from the treatment T_5 and the highest nodulation was also found in T_5 treatment. The highest net return TK. 43977 ha^{-1} at Gazipur and TK. 98857 ha^{-1} at Jessore and benefit cost ratio 2.18 at Gazipur and 3.66 at Jessore were counted from the treatment T_5 followed by T_4 and the lowest were in T_1 treatment. Therefore, the appliction of 60 kg or 50 kg K ha^{-1}may be considered as economically profitable dose for lentil yield maximization in terrace and calcareous soils of Bangladesh.

Integrated nutrient management on growth and yield of lentil

A field experiment was conducted at the Pulse Research Sub-station of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2015-16 to evaluate the effect of growth and yield parameters of lentil with organic and inorganic nutrients and to determine the optimum rate of nutrients for lentil. Five different combination of nutrients viz. FRG 2012, 75% FRG + 25% CD, 50% FRG + 50 % CD, 75% FRG + 25% PM, 50% FRG + 50% PM were included in the study with one control native fertility. The effect of fertilizer combinations on the plant growth parameters was not significant but yield characters varied significantly. The higher seed yield was produced in the treatment FRG 2012 (1105kg/ha),75% FRG +25% CD(1101 kg/ha) and 75% FRG + 25% PM (1098 kg/ha).

Chickpea

Varietal Improvement

Hybridization of chickpea

Hybridization of chickpea was conducted to obtain genotypes having desired gene combinations during rabi, 2015-16 at Pulses Research Centre, Ishurdi, Pabna. Six parents were used and a total of 117 successful crossed seeds were collected from fifteen cross combinations.

Confirmation of F_1 of chickpea

Confirmation is essential to ensure fertile crosses between the parents. Fifteen F_1s obtained from rabi 2014-15 were grown along with their parents at Pulses Research Centre, Ishurdi, Pabna. Finally, fifteen F_1s were confirmed, harvested separately which will be grow in the next year.

Growing F_4 generation of chickpea

To advance the generation from F_4 to F_5 six F_4s were grown along with check at Pulses Research Centre, Ishurdi, Pabna. Among the cross combination 11-17 plants were selected from each progeny and harvested separately which will be grown in F_5 generation in the next season.

Observation trial of chickpea

Twenty four families selected from last year's F_5 were grown against check variety BARI Chola-5 and BARI Chola-9 during rabi 2015-16 at Pulses Research Centre, Ishurdi, Pabna. The experiment was laid out in a RCB design with two replications and having a spacing of 50 cm between rows. ICCX 060157-3 took lowest days to flowering as well as maturity. Highest pods per plant were found in BCX 01008-11 followed by BARI Chola-9 and lowest in BCX 01007-7 and ICCV 93706. Bold size seeds were obtained from ICCMABCA-41. The highest yield was obtained from BCX 01008-8 followed by BCX 01008-4 and BCX 01007-3. Finally, five entries BCX 01008-8, BCX 01008-4, BCX 01008-3, ICCV 07105 and ICCX 060157-3 are selected on the basis of higher yield, higher pods per plant, lowest days to mature and BGM reaction for PYT in the next rabi season.

Preliminary yield trial of chickpea (Set I)

The experiment was carried out to evaluate the performance of five chickpea genotypes along with check BARI Chola-5 and BARI Chola-9 for yield and yield related traits in three locations during rabi 2015-16. Significant differences were observed for all the genotypes against plant population (PP)/m^2, days to flower, plant height and 100 seeds weight. Considering mean data for days to maturity BCX09010-2 was found earlier compare to check. From the mean data across location ICCV93954 gave the highest pod/plant followed by BCX09015-7. Bold seeded entry was recorded as ICCV 93954 where BARI Chola-5 possessed the smaller sized seeds. GGE biplot analysis revealed that three genotypes (three genotypes BCX09010-2, BCX09015-7 and ICCV93954) was found better compare to others. So BCX 09010-9, BCX09015-7 and BCX 09010-2 are selected to evaluate in the next rabi season under RYT.

Preliminary yield trial of chickpea (Set II)

The experiment was conducted out to evaluate the performance of six exotic chickpea genotypes along with check varieties BARI Chola-5 and BARI Chola-9 for yield and yield contributing characters under PRC at Ishurdi,Gazipur and Jessore during rabi 2015-16. ICCX 060157-11 and ICCX 060157-15 was earlier compare to check. The highest pods/ plant were obtained from genotypes ICCV 12110 and ICCV 07102 and lowest from genotype ICCX 060157-11.Finally three entries ICCV 07102, ICCV 12115 and ICCX 060157-15 are selected on the basis of higher seed yield, bold seed and earliness.

Regional yield trial of chickpea

The experiment was carried out to find out the performance of five chickpea genotypes along with check varieties BARI Chola-5 and BARI Chola-9 for yield and yield related traits during rabi 2015-16. Almost all of the entries took similar duration for both flowering and maturity. From the mean data of different location highest pods/plant was obtained from BARI Chola-5 followed by BCX08001-3. Bold seeded entry was recorded as BCX 08009-9 and BARI Chola-9 where BCX 08001-3 had the smaller sized seed. Entries BCX 08009-9 and BCX 08001-3 are selected to evaluate in the next rabi season on PVS.

Participatory variety selection of chickpea

The field experiment was carried out at Barind, Jessore and Barisal during Rabi season of 2015-16 to find out suitable line/genotype(s) of chickpea. Among the kocation BCX06004-10 was found earlier compare to Barind and Jessore. In case of number of pods/plant highest in Jessore for all the genotypes. The entries BCX06004-10 and BCX06001-11 could be tested in the next year.

Pest Management

Screening of chickpea germplasm resistant to botrytis gray mold

A field experiment was conducted at Regional Pulses Research Station (RPRS), Madaripur during Rabi season of 2015-16 to find out high yielding and botrytis gray mold disease resistant variety of chickpea. Results showed that none of the tested entries were resistant to BGM. There were seven germplasms (BCX 09010-2, BCX 09015-7, BCX 09010-6, BCX 08010-9, BCX 08001-3, BCX 06001-11, ICCV-98801) which showed moderately resistant reaction to the disease. The line BCX-06001-11 gave the highest seed yield (450.70g) and the lowest (90.00 g) from ICCV-92944.

Efficacy of fungicides in controlling botrytis gray mold of chickpea

Five different fungicides Knowin 500SC (Carbendazim), Secure 600WG (Fenamidone+Mancozeb), Nativo75WG(Tebuconazole+Trifloxystobin), Acrobat MZ (Metalaxyl+Mancozeb), Indofil (Mancozeb) and control were evaluated under natural condition at Regional Pulses Research Station, Madaripur. Results revealed that among the five fungicides Secure 600WG (Fenamidone+Mancozeb), Knowin 500SC (Carbendazim) treated plots showed best diseases score (both 2.33) against BGM and produced the highest seed yield (1052, 1015 kg/ha respectively) and increase of yield over control (61.21, 61.17% respectively). The highest disease score (5.33) and lowest yield (408 kg/ha) was obtained in untreated control plot.

Fieldpea

Varietal Improvement

Hybridization of pea

Hybridization of fieldpea was conducted to obtain genotypes having desired gene combinations during rabi, 2015-16 at Pulses Research Centre, Ishurdi, Pabna. Six parents were used and a total of 158 successful crossed seeds were collected from fifteen cross combinations.

Confirmation of F_1 of pea

Confirmation is essential to ensure fertile crosses between the parents. Thirteen F_1s obtained from rabi 2014-15 were grown along with their parents at Pulses Research Centre, Ishurdi, Pabna. Finally, nine F_1s were confirmed, harvested separately which will be grown in the next year.

Participatory variety selection of pea (long duration type)

The experiment was conducted at four locations in the farmer's field during Rabi 2015-16 to find out desirable lines through farmer participation.The genotype BD4223 was earlier compare to others. Considering pod/plant genotypes BD7211 and BD4209 and 100 seeds weight the entries BD4209 was found better. GGE biplot analysis revealed that the genotypes BD4209, BD7211 and BD4223 showed stable performances over the tested locations.

Participatory varietal selection of pea (short duration type)

The experiment was conducted at OFRD, Pabna and Jessore during rabi 2015-16 to find out desirable line of pea over different locations. Among the short duration genotypes, the highest mean seed yield was recorded in Pea 88 (1478 kg/ha) followed by BARI Motorshuti-3 (1298 kg/ha). Early-97 produced the highest number of pods per plant (6.74) whereas the lowest number (5.80) counted in BARI Garden pea-3. The highest plant height was observed in Early-97 (90.80 cm) followed by Pea-88 (52.80 cm) while the highest mean100 seed weight (24 g) was recorded BARI Motorshuti-3 followed by Pea-88. The short duration line Pea-88, 34223 and Early-97 can be selected in between T. aman and T. aus rice for vegetable or seed purpose as relay or sole crop.

Evaluation of pea genotypes

Eleven genotypes collected from different areas of the country with IPSA Garden pea-3 were evaluated at Pulses Research Centre, Ishurdi, Pabna during rabi 2015-16. Yield and yield contributing characters showed significant differences among the genotypes. Genotypes 244105 was earlier and Faridpur local late. Highest pods/plant was obtained from Natore local-1 and lowest was obtained from 244105 genotype. Among the entries highest yield was obtained from Natore local-1 followed by Jhikorgacha local and Sekim local.

Crop nutrition

Effect of zinc and boron on yield and yield contributing characters of field pea

An experiment was conducted at on-station RPRS, Madaripur, PRSS, Gazipur and RARS, Jessore during the Rabi season of 2015-16. The objectives were to evaluate the effect of zinc (Zn) and boron (B) on the yield and yield contributing characters of fieldpea (Pisum sativum) and to estimate the optimum dose of Zn and B for yield maximization. There were 16 treatment combinations comprising four levels each of zinc (0, 1.0, 2.0 and 3.0 kg ha^{-1}) and boron (0, 1.0, 1.5 and 2.0 kg ha^{-1}) along with a blanket dose of N_{12} P_{22} K_{30} S_{10} kg ha^{-1} was used. The treatments were arranged viz. T_1= Zn_0 B_0;T_2= Zn_0 $B_{1.0}$; T_3= $Zn_0B_{1.5}$;T_4= $Zn_0B_{2.0}$;T_5= $Zn_{1.0}B_0$;T_6=$Zn_{1.0}B_{1.0}$; T_7= $Zn_{1.0}B_{1.5}$;T_8= $Zn_{1.0}B_{2.0}$; T_9= $Zn_{2.0}B_0$;T_{10}= $Zn_{2.0}B_{1.0}$;T_{11}= $Zn_{2.0}B_{1.5}$;T_{12}= $Zn_{2.0}B_{2.0}$; T_{13}= $Zn_{3.0}B_{0;}$ T_{14}= $Zn_{3.0}B_{1.0;}$ T_{15}= $Zn_{3.0}B_{1.5;}$ andT_{16}= $Zn_{3.0}B_{2.0.}$. The combination of $Zn_{3.0}B_{2.0}$ was produced significantly higher seed yield at Madaripur, Gazipur and Jessore followed by $Zn_{3.0}B_{1.5}$. The combined application of zinc and boron were observed superior to their single application. Therefore, the combination of $Zn_{3.0}B_{2.0}$ and$Zn_{3.0}B_{1.5}$ may be considered as suitable dose for fieldpea cultivation in calcareous and terrace soils of Bangladesh.

Grasspea

Preliminary yield trial of grasspea

Ten entries including two check varieties BARI Khesari-2 and BARI Khesari-3 were evaluated at PRC, Ishurdi; RPRS, Madaripur and Shatkhirain a RCB design with 3 replications. Considering mean value over the location the genotype IF1942 produced highest number of pods followed by BKX003-1, Patuakhali local. The highest mean of 100 seeds weight was observed in BKX003-1 followed by BKX002-4 and Sel-1348. None of the entry was out yielded over the check varieties at all the locations but considering GGEbiplot analysis the entry BKX003-1, BKX - 0002-4 and SEL – 1348 showed *better performance* .

Screening of grasspea germplasm under relay condition

The field experiment was conducted at Pulses Research Centre of Bangladesh Agricultural Institute (BARI), Ishurdi, Pabna, during rabi season 2015-16 to find out the best germplasms as well as higher yield of grasspea under relay condition using a randomized complete block design with two replications. Significant genotypic differences were detected for all recorded traits except plant height and 100 seed weight. The entry BARI Khesari-3 genotypes matured earlier than others. The highest plant height was found from Nirmal (73.2cm) and lowest was found in BARI Khesari-3 (56.5cm). The genotype Sel-1348 produced higher pods per plant than other genotypes. Bold size seeds were obtained from Nirmal. The highest seed yield was obtained from Sel-1348 (1508 kg/ha) followed by

Sirajgonj local and BKX-0003-1. Three genotypes Sel-1348, Sirajgonj local and BKX-0003-1 are selected for next year trail.

International grasspea segregating population F_5 nursery (ICARDA)

Ten Grasspea lines including one local check were evaluated at Pulses Research Sub-Center, BARI, Gazipur during rabi 2015-16. The local check BARI Kheseri-2 were earlier than the exotic entries considering days to 50% flowering and 95% maturity. IFLA1900XWaise was the earliest among the exotic lines. No exotic lines could exceed the local check in case of yield. The imported lines IFLA1900XWaise, IFLA288XIFLA299, BARI-K2XK209, IFLA3026XBARI-K2and the local collection were the high yielding entries.

International grasspea yield trial-low-b-ODAP (ICARDA)

Twenty five grasspea lines including one local check were evaluated at Pulses Research Sub-Center, BARI, Gazipur during rabi 2015-16. The local checks BARI Kheseri-2 were earlier than the exotic entries considering days to 50% flowering and 95% maturity. IFLA3001, IFLA119, IFLA118 and IFLA1439 was the earliest among the exotic lines. No exotic lines could exceed the local check in case of yield. The imported lines IFLA1419, IFLA1826 IFLA2341, IFLA119, IFLA118, IFLA2781, IFLA2750, bio520 and the local collection were the high yielding entries.

International grasspea yield trial-early (ICARDA)

Twenty five Grasspea lines including one local check were evaluated at Pulses Research Sub-Center, BARI, Gazipur during rabi 2015-16. The local check BARI Kheseri-2 were earlier than the exotic entries considering days to 50% flowering and 95% maturity. IFLA2924, IFLA1522 and IFLA2475 and IFLA2765 was the earliest among the exotic lines. No exotic lines could exceed the local check in case of yield. The imported lines IFLA2998, IFLA2282, IFLA2924, IFLA2158, IFLA2968, IFLA2974, IFLA159, IFLA2765, IFLA220, IFLA2460, IFLA2736, IFLA1720, IFLA2395 and the local collection were the high yielding entries.

.**Screening of advanced grasspea genotypes/lines in saline soil**

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2015-16 to evaluate the performance of different genotypes/lines under saline soil. There were 4 genotypes of grasspea (SEL-1348 (E1), BKX-002-4 (E2), Serajgonj local (E3) and Satkhira local where BARI khesari-3 was used as check variety). BARI Khesari-3 gave the highest yield (1.5 t/ha) followed by BKX 002-3 (1.5 t/ha) and Serajgonj local had the lowest yield (1.18 t/ha). Satkhira local is the short durational (113 days) one among the studied varieties. The lowest level (3.2 dS/m) of soil salinity was recorded in the sowing time and the highest level of salinity (10.2dS/m) was recorded at the harvesting stage.

Cultural Practices

Performance of different khesari (*lathyrus sativus* l.) cultivars relaying with t.aman rice

A field experiment was conducted at Pulses Research Center and Regional Agricultural Research Station, Ishurdi during rabi season of 2015-16 to find out the effect of different cultivars on the growth and yield of Khesari under relay condition. The experiment was conducted in randomized complete block design (RCB) with three replications.There were four cultivars BARI Khesari-1, BARI Khesari-2, BARI Khesari-3 and Sirajgonj local. The highest seed yield (853 kg/ha) was obtained from Sirajgonj local cultivar followed by BARI Khesari-2 (548 kg/ha) and BARI Khesari-1 (573 kg/ha). The highest pods/plant might be contributed to higher grain yield in Sirajgonj local cultivar.However, this study will be continued in 2016-17 with few others cultivars to draw concrete conclusion.

Crop nutrition

Effect of phosphorus and moisture level on yield and BOAA content of lathyrus

A field experiment was conducted at PRC, Ishurdi and PRSS, Gazipur during rabi season of 2015-2016 to find out the effect of phosphorus with moisture level on yield and BOAA content of lathyrus. There were two moisture levels - control and light irrigation at 20 DAE which were placed in the main-plot and 5 'P' levels - Control, 10, 20, 30 and 40 (kg/ha) were in the sub-plot. The experiment was laid out in a–split-plot design with 3 replications. The yield of lathyrus was not significantly affected either by moisture levels or different P levels.

Mungbean

Varietal Improvement

Hybridization of mungbean

Hybridization was conducted during Kharif-I, 2016 at PRC, Ishurdi, Pabna. Six parents were used having desired genetic combinations and a total of 472 successful crossed seeds were collected from fifteen cross combinations.

Confirmation of F_1 of mungbean

Confirmation is essential to ensure fertile crosses between the parents. Seventeen F_1s obtained from Kharif-I, 2015 were grown along with their parents at Pulses Research Center, Ishurdi, Pabna during Kharif-I, 2016. On the basis of desired characters sixteen accessions were selected as confirmed cross comparing between two parents and were harvested separately for the next year.

Growing of F_2 generation of mungbean

Maximum segregation is attained in F_2 generation and with a view to select appropriate and desired combinations eight F_{2s} were grown along with check at Pulses Research Center, Ishurdi, Pabna during Kharif 1, 2016. The whole population was bulked for the retention of wide variability which will be grown in the next Kharif-I season.

Growing of F_3 generation of mungbean

To advance the generation from F_3 to F_4 and with a view to select appropriate and desired combinations three F_{3s} were grown along with check at Pulses Research Center, Ishurdi, Pabna during Kharif I, 2016. The whole population was bulked for the retention of wide variability which will be grown in the next Kharif I season.

Growing F_4 generation of mungbean

To advance the generation five F_4s were grown along with check at Pulses Research Center, Ishurdi, Pabna during Kharif 1, 2016. 7-16 plants were selected from each entry which will be grown in the next Kharif-I season.

Growing F_5 generation of mungbean

Six F_5s were grown along with check at Pulses Research Center, Ishurdi, Pabna during Kharif-I 2016. Twenty eight lines were selected from six accessions on the basis of yield, disease resistance and other desirable characters which will be grown in the next Kharif-I season.

Observation trial of mungbean

A total of eighteen lines were grown with check variety BARI Mung 6 in kharif-1, 2016 at Pulses research centre, Ishurdi, Pabna. Among the test entries significant differences were observed in all studied characters except pods/plant. Highest pods per plant (24) were found in BMXK1-15009-1 followed by BMXK1-10007-1 and lowest (13) in BMXK1-15009-3and BMXK1-10002-2. Bold size seeds (7.03 g) were obtained from BMXK1-10011-1 followed by BMXK1-10011-3. The highest yield (1837 kg/ha) was obtained from BMXK1-10011-3 followed by BMXK1-10012-2, BMXK1-10007-5 and BMXK1-10009-4 and lowest yield (966 kg/ha) from BMXK1-10002-2 followed by BMXK1-10006-2 and BMXK1-15009-1. Five entries BMXK1-10011-3, BMXK1-10012-2, BMXK1-10009-4, BMXK1-10007-5 and BMXK1-10007-3 were selected for next PYT.

Preliminary yield trial of mungbean

The experiment was conducted at Pulses Research Centre, Ishurdi, Regional Agricultural Research Station, Jessore, and Pulses Research Sub Centre, Gazipur and Madaripur during Kharif-I, 2016 to find out desirable lines of mungbean. GGE biplot analysis considering to four location revealed that genotypes $BMXK_1$-09012-1, $BMXK_1$-09015-2 was found better compare to other genotypes.

Regional yield trial of mungbean

Seven genotypes including one check variety BARI Mung-6 were evaluated at Pulses Research Center, Ishurdi, Pabna; PRSS, Madaripur and RARS, Rahmatpur, RARS Jessore and Gazipur during Kharif-I, 2016.Considering mean values over location among the entries the highest number of pods per plant and 100 seed weight was recorded in BMX-08011-8 followed by BMX-08011-2. BMx08011-2 and BMX08011-8 selected for PVS in the next year.

Participatory varietal selection of mungbean

The experiment was conducted at Jessore, Madaripurand Barishal during kharif-1 and late rabi season, 2016 to find out desirable lines of mungbean over different locations. The genotype BMXK1-07007-4 matured earlier (59 days) according to the mean data of three locations. The highest mean pods per plant recorded from genotype BMXK1-07007-4. Bold seeded seed was recorded in BARI Mung-6where BMXK1-07007-4possessed the smaller sized seeds. All genotypes showed resistance to YMV. Maximum mean yield was obtained from BMXK1-07007-4 followed by BMXK1-06006-4. Genotypes BMXK1-07007-4, BMXK1-06006-4 and BMXK1-06001 were selected in the next year trail.

Genetic mapping for quantitative trait loci for maturity of mungbean *vigna radiata* l. wilczek.

In this study, we report quantitative trait locus (QTL) mapping in mungbean using an F_2 population of 142 lines derived from a cross between KPS-I (75-80 days) and BARImung 6 (55-60 days). $F_{2:3}$ lines grown under field condition at Gazipur 2016. Single marker analysis suggested at least five loci controlling maturity. Composite interval mapping consistently identified four QTLs, qMAT1,qMAT2, qMAT3, qMAT6 and qMAT8, on linkage groups 1, 2, 3,6 and 8. TheseQTLs accounted for 7.54 to 18.83% variation depending on different linkage group.

Evaluation of mungbean germplasm

Fourteen accessions were grown with check variety BARI Mung 6 in kharif-1, 2016 at Pulses research centre, Ishurdi, Pabna. Among the test entries significant differences were observed in all studied characters. Highest pods per plant (29) were found in Sonali followed by Meha and lowest (15) in BARI Mung 6. Bold size seeds (7.03 g) were obtained from BMX-97024-13 followed by BARI Mung 6 and small size seeds (3.98 g) from BMX-9009-6. The highest yield (1310 kg/ha) was obtained from BMX-97024-13 followed by Sukumar, IPM-02-03 and TMB 37 and lowest yield (915 kg/ha) from Pusa Vishal followed by PM-2 and BMX-9009-6.Finally, four entries BMX-97024-13, Sukumar, IPM-02-03 and TMB 37are selected for different breeding trials in the next year.

Regional trials on mungbean in SAARC member countries

Ten entries of mungbean collected from Bangladesh, India, Nepal and Pakistan were evaluated at Pulses Research Centre, Ishurdi, Pabna during Kharif I, 2016 which laid out in a RCB design with 3 replications with a view to select promising genotypes. Significant differences among the genotypes were observed in case of all characters studied. The entry MB-03 followed by MB-04 and MB-06flowered earlier. In case of maturity, MB-04 followed by MB-03 and MB-08 matured earlier. Highest pods/plant was obtained from MB-09 followed by MB-10 and lowest was obtained from MB-01. Among the entries highest yield (901 kg/ha) was obtained from MB-06 followed by MB-03 and MB-08.

Pest Management

Screening of mungbean lines resistant to YMV and CLS

An experiment was conducted at Regional Pulses Research Station, Madaripur to evaluate the performance of mungbean genotypes for searching of high yielding and resistant source of Yellow Mosaic Virus (YMV) and Cercospora Leaf Spot (CLS) of mungbean. Twenty mungbean lines with a check BARI Mung-3 were evaluated in the trial. Results revealed that BD-6926 and BD-6941 gave the lowest MYMV score (2.33) where the line BD-6928 and BARI Mung-3 gave the highest MYMV score (7.33). All the germplasm showed resistant to CLS score. The highest seed yield (1698 kg/ha) was obtained in BD-8887 followed by (1659 kg/ha) in BD-6926 and the lowest yield (1063 kg/ha) was found in BARI Mung-3.

Screening of high yielding mungbean lines resistant to YMV and CLS

Twenty one mungbean lines with a check BARI Mung-3 were screened out for searching of YMV and CLS resistant genotypesat Regional Pulses Research Station, Madaripur. Results revealed that the lines BMMP-201515, BMMP-201524 and BMMP-201525 gave lowest MYMV score (2.00) where the line BMMP-201511 and BARI Mung-3 gave the highest score (7.33). Almost all the germplasm showed resistant to CLS score. The highest yield (1417 kg/ha) was obtained in BMMP-201513 and the lowest (891 kg/ha) was found in the line BMMP-201517.

Evaluation of high yielding advanced lines of mungbean resistant to YMV and CLS

Four selected advanced lines viz. VC-6173, VC-3960A-88, GK-22, SM2-134with a check BARI Mung-1 were evaluated at Regional Pulses Research Station, Madaripur. Results revealed that the line VC-6173 and SM2-134 showed lowest MYMV score (2.33) where BARI Mung-1 gave the highest YMV score (4.33). Almost all the germplasm showed resistant CLS score. The line SM2-134 gave the highest (1525 kg/ha) yield followed by (1469 kg/ha) in GK-22 and the lowest yield (830 kg/ha) found in the BARI Mung-1.

Evaluation of advanced lines of mungbean resistant to MYMV and CLS

Six selected advanced lines with a check BARI Mung-1 were evaluated at Regional Pulses Research Station, Madaripur. The lines were BMXK1-06006-4, GK-24, MMLI-V12, BD-6921 and MMB-V01. Results revealed that the line BMXK1-06006-4 gave lowest MYMV score (1.33) where the line BD-6921 gave the highest YMV score (4.66). Almost all the germplasm showed resistant to CLS score. The line BMXK1-06006-4 gave the highest (1310 kg/ha) yield followed by (1137 kg/ha) in MMB-V01 and the lowest yield (875 kg/ha) was found in BARI Mung-1.

Evaluation of different management packages against flower thrips and pod borers of mungbean (*vigna radiata* l.)

Efficacy and profitability of different management packages comprising white sticky trap, bio-pesticide and synthetic insecticides were evaluated against flower thrips and pod borers of mungbean at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-1 2016. All the treatments reduced flower infestation by thrips and pod borer infestation significantly. The highest percentage of flower infestation and thrips population reduction was observed in by installing white sticky trap + spraying of chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG) followed by farmers practice (spraying imidacloprid). Again, the highest pod borer infestation reduction was found in by installing white sticky trap + spraying azadirachtin (Bio-neem plus 1EC) + spraying with spinosad (Success 2.5 SC) treated plots followed by installing white sticky trap + spraying chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG). The highest grain yield was obtained from installing white sticky trap + spraying chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG) but the highest return come from farmers practice (spraying imidacloprid). This might be due to the higher cost of Intrepid 10 SC and Proclaim 5 SG reduced the return and benefit. Therefore, considering the efficacy and benefit, it is seen that the evaluated IPM package could not be profitable against low level infestation of flower thrips and pod borer infestation. It could be profitable that areas where serious out break of flower thrips and pod borer occurs.

Cultural Practices

Efficacy of herbicides on weed control in mungbean cultivation

A field experiment was conducted at PRC, Ishurdi, Pabna and PRSS,BARI,Gazipur during Kharif-I season of 2016 to find out the suitable herbicide for controlling weed and low cost weed management option for mungbean cultivation. The weed management options were — T1=Pre-sowing Whipsuper(Fenoxyprop-P- ethyl) @ 1.3 ml/liter water,T2= Pre sowing Release (Fenoxyprop-P- ethyl) @ 1.3ml/liter water, T3=Pre-sowing Tyzalo super (Quizalofop-P- ethyl)) @ 1.3ml/liter water, T4=Post sowing Whip supper, T5=Post sowing Release, T6=Post sowing Tyzalo super,T7=Hand weeding at 20 DAE, T8=Weed free plot (weeding at 15 days interval 3 time) and T9=Control (no weeding). Weed free plot gave the higher seed yield (1113 kg ha-1 and 1210 kg ha-1) of mungbean followed by post-sowing whip super (940 kg ha-1 and 1035kg ha-1) and the lowest seed yield (481 kg ha-1 and 526 kg ha-1) was recorded in the control at Ishurdi and Joydebpur, respectively. The highest gross return and MBCR were found in post-sowing whip super. The lowest net return found in pre-sowing release and MBCR were found in weed free plot at Ishurdi and Joydebpur, respectively.

Cowpea

Screening of cowpea genotypes in the southern region

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during two consecutive *Rabi* seasons of 2014-15 and 2015-16 to find out the suitable genotypes of cowpea for better adaptation and higher yield in southern region of Bangladesh. In 2014-15, 15 entries of cowpea along with one check (cv. BARI Felon-1) were taken but, eight selected entries (from first year) and one check variety (BARI Felon-1) were taken in 2015-16 for the adaptation trial. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 2 rows ×2 m long. Seeds were sown on 26 November 2014 and 15 November 2015. In 2014-15, days to flowering, days to maturity, number of pod/plant, 100-seed weight and grain yield of different entries significantly varied of cowpea. However, in second year, number of days to flowering, final plant population, number of pod/plant, 100-seed weight and grain yield differed significantly among the selected entries. The cowpea entry CPS-13 showed the highest yield of grain (1415 kg/ha) followed by CPS-6 (1305 kg/ha) and CPS-12 (1233 kg/ha), while the check variety (BARI Felon-1) gave lower yield (1174 kg/ha). The cowpea entries CPS-13, CPS-6 and CPS-12 should be tested in the next season for making final recommendation.

4 OILSEED CROPS

Rapeseed and mustard (*Brassica* spp.)

Varietal Development

Development of convergent crosses in *Brassica rapa*

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and BARI Sarisha-6 were used as female parents and S_6 generation of BARI Sarisha-9 and Tori-7 were used as male parents to develop single crosses during rabi 2014-15. F_1s were crossed with BARI Sarisha-6 and BARI Sarisha-17 to develop three-way crosses. One thousand six hundred and two buds were crossed from 93 plants from which two thousand nine hundred and thirty five seeds were obtained. Crossed seeds were stored for the next season.

The experiment consisted of BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17, BARI Sarisha-6, BARI Sarisha-9 and Tori-7 as parents was conducted at Gazipur during rabi 2015-16. BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and BARI Sarisha-6 were used as female parents and S_6 generation of BARI Sarisha-9 and Tori-7 were used as male parents to develop single crosses during rabi 2014-15. F_1s were grown during rabi 2015-16 and crossed with BARI Sarisha-6 and BARI Sarisha-17 to develop three-way crosses. Seeds were sown on 9 November 2015 at Joydebpur. Proper bagging was done to protect out crossing. Crossing was done through bud pollination.

Number of crossed plants from different cross combinations ranged from 10-15 and total 93 plants were crossed. One thousand six hundred and two buds were crossed from 93 plants to develop three-way crosses. Seven hundred and eighty four siliquae, and two thousand nine hundred and thirty five seeds were obtained. Crossed seeds were stored for the next season.

Development of BC_2S_2 in *Brassica rapa*

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-9 (S_4) and Improved Tori-7(S_4) were crossed with Local Tori-7 to transfer short duration gene from Tori-7 to high yielding varieties. BC_2S_1 plants were selfed to develop BC_2S_2. One thousand one hundred and seventeen buds were selfed from 75 plants from which two thousand two hundred and fifty four seeds were obtained. Selfed seeds were stored to develop BC_2S_3 in the next season.

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-9 (S_4) and Improved Tori-7 (S_4) were crossed with Local Tori-7 (LT-7) during rabi 2011-12 to develop F_1. Developed six F_1s were crossed with LT-7 to develop BC_1 and BC_2 during rabi 2012-13 and 2013-14. BC_2S_1 were were developed during rabi 2014-15 through selfing. BC_2S_1 seeds were sown on 9 November 2015 to develop BC_2S_2. Proper bagging was done to protect out crossing. Early plants were selected for selfing. Selfing was done through bud pollination.

Number of selfed plants from different cross combinations ranged from 6-16 and total 75 plants were selfed to develop BC_2S_2. One thousand one hundred and seventeen buds were selfed from 75 plants. Five hundred and twenty one siliquae, and two thousand two hundred and fifty four seeds were obtained. Selfed seeds were stored to develop BC_2S_3 in the next season.

Development of short duration inbred lines in *Brassica rapa*

The most adaptive variety Tori-7, high yielding variety BARI Sarisha-9, BARI Sarisha-12 and Kalaynia were used as source populations for developing inbred line.In total 286 selected plants were selfed from four source populations. Total 3652 buds were selfed from which 1340 effective siliquae and 5283 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines in the next year.

The most adaptive variety Tori-7, high yielding variety BARI Sarisha 9, BARI Sarisha 12 and Kalaynia were used as source populations. Selfed seeds from individual plant of source populations obtained from previous year were sown following plant to row method. Selfed seeds were sown along with Local Tori-7 as check. Seeding was done on 9 November 2015. Short duration plants were selected comparing with check vatiety for selfing. Proper bagging was done to protect out crossing. Selfing of plants was done through bud pollination.

Ninety six plants were selected from 32 rows of Tori-7, 72 plants from 30 rows of BARI Sarisha-9, 63 plants from 28 rows of BARI Sarisha-12 and 55 plants from 24 rows of Kalaynia for selfing for advancing S_5 to S_6 generation. Total 286 selected plants were selfed from four source populations. Total 3652 buds were selfed from which 1340 efective siliquae and 5283 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines in the next year.

Gene pyramiding of 16 genotypes of *Brassica rapa* into a single parent

Four double way crosses were used in the crossing program to create complex cross for accumulation of desired gene into a single parent. A total of 73% crosses were successful to produce siliquae and seeds. F_1 generation of double way cross combinations were also advanced for F_2 generation.

Eight brown sarson parents and eight yellow sarson parents were utilized to produce single crosses from different developed varieties as well as advanced lines of rapeseed –mustard. Eight single crosses [(Tori-7 x BARI-Sarisha-12, Din-2 x BC 2193, BARI Sharisha-9 x Kalyania, BARI Sharisha-14 x S-6, BARI Sarisha-6 x Sonali Sarisha, BARI Sharisha-14 x BARI Sharisha-15, Jumka x BARI Sarisha-17 and SAU-1 x BC-100614)] made in 2013-14 have been used to achieve double cross in 2014-15. The double crosses [(Sau-1 x BC -100614) x BARI Sar. -1 x S-6)], X [(BARI Sar.-6 x Sonali Sar.) x (Tori-7 x BARI-Sar.-12)], [(BARI Sar.-14 x BARI Sar.-15) x (BARI Sar.-9 x Kalyania)] and [(Jumka x BARI Sarisha-17) x (Din-2 x BC 2193)] were sown two times on 2 November and 9 November 2015 to synchronize the flowering for hybridization. In the 1st sowing of the experiment, the entries flowered on 5 December to 6 December 2015. In the 2nd sowing, the entries flowered on 12 December to 15 December 2015. The hybridization have been done with the following cross combinations, [(Sau-1 x BC -100614) x (BARI Sar. -1 x S-6)] X [(BARI Sar.-6 x Sonali Sar.) x (Tori-7 x BARI-Sar.-12)] and [(BARI Sar.-14 x BARI Sar.-15) x (BARI Sar.-9 x Kalyania)] X [(Jumka x BARI Sarisha-17) x (Din-2 x BC 2193)]. Inter cultural operations were done when necessary. Hybridization was started on 16 December 2015.

A total of 228 buds were crossed from which 166 siliquae were developed and 2382 seeds were produced. About 73% crosses were succeeded to produce siliquae and F_1 seed. F_1 seeds of complex crosses of eight parents were stored to combine of sixteen parents in to a single parents and finally to exploit the desirable genotypes from the F_2 and sub sequent segregating generations in future.

Evaluation of segregating generations of *Brassica rapa*

Progenies of F_5 generation of five cross combinations having both yellow and brown seed coat colour were evaluated. Progenies of F_6 generation (Set-I) of four cross combinations having brown seed coat colour were evaluated. Progenies of F_6 generation (Set-II) of six cross combinations having both yellow and brown seed coat colour were evaluated. Single plant selection method was followed. Plants were selected considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance. Desirable plants were selected from each progeny and seeds of selected plants were bulked and stored for evaluation in the next year.

Progenies of F_5 generation of five cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2015-16 at Joydebpur. Progenies were sown following progeny to row method along with BARI Sarisha-14 as check in 3-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 10 November 2015. Single plant selection among progenies was done based on short duration (maturity duration upto 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

Progenies of F_6 generation (Set-I) of four cross combinations having brown seed coat colour were evaluated during rabi 2015-16 at Joydebpur. Progenies were sown following progeny to row method along with BARI Sarisha-14 as check in 3-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 11 November 2015. Single plant selection among progenies was done based on short duration (maturity duration upto 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

Progenies of F_6 generation (Set-II) of six cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2015-16 at Joydebpur. Progenies were sown following progeny to row method along with BARI Sarisha-14 as check in 3-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 10 November 2015. Single plant selection among progenies was done based on short duration (maturity duration upto 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_5 generation

Seventeen progenies having yellow seed coat colour from three cross combinations and eight progenies having brown seed coat colour from four cross combinations were evaluated. Single plant selection method was followed. Plants were selected considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance. Desirable plants were selected from selected progenies and seeds of selected plants were bulked and stored for evaluation in F_6 generation in the next year.

F_6 generation (Set-I)

Progenies having brown seed coat colour from four cross combinations were evaluated. Single plant selection method was followed. Considering earliness (maturity duration upto 87 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, progenies were selected or discarded. Thirty nine desirable plants were selected from four progenes. Seeds of selected plants were harvested seperately and stored for evaluation in Observation Trial in the next year.

F_6 generation (Set-II)

Forty seven progenies having yellow seed coat colour from four cross combinations and eight progenies having brown seed coat colour from two cross combinations were evaluated. Single plant selection method was followed. Plants were selected considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance. Desirable plants were selected from selected progenies and seeds of selected plants were bulked and stored for evaluation in the next year.

Evaluation of f_2 generation of *Brassica rapa*

A total of 108 plants were harvested from the 7 cross combination considering the yield per plant, seed size, and seed coat color and siliquae shape. Out of 140, 41 single plants were selected finally and will be as grown as F_3 to in the next year.

A total of 7 entries from 7 cross combinations were sown on November 17, 2015 in 3 meter long of 2 rows along with the parents as check at Ishurdi. A total of 140 single plants were harvested separately from the mention cross combinations considering yield per plant and seed coat color. Forty one (41) single plants out of 140 were selected finally which will be to advance generation from F_2 to F_3.

Observation trial of *Brassica rapa* (Set-I)

Twenty five lines of Brassica rapa having yellow flower and yellow seed coat colour along with check as BARI Sarisha-14 were evaluated without replication. Variations were observed among the lines for all the characters studied. Maturity duration ranged from 85-92 days. Six lines were matured within 85 days whereas check variety BARI Sarisha-14 took 86 days. Plant height ranged from 71-99 cm. No. of siliquae/plant ranged from 46-119. The highest no. of siliquae/plant recorded in BC 2014-Y04 (Net). No. of seeds/siliqua ranged from 12-28. The highest no. of seeds/siliqua recorded in BC 2014 -Y03. Thousand seed weight ranged from 2.67-3.96 g. Seed yield ranged from 1155-2950 kg/ha. The highest seed yield recorded in BC 2014-Y03 (Net) (2950 kg/ha). Considering earliness, seed yield and other yield contributing characters, four lines BC 2014-Y03 (Net), BC 2014-Y02 (Net), BC 2014-Y02 and BC 2014 -Y01 were selected for the next trial.

Observation trial of *Brassica rapa* (Set-II)

Twenty four lines of Brassica rapa having brown seed coat colour along with one check as BARI Sarisha-9 were evaluated with two replications under Observation Trial of Brassica rapa (Set-II) at Gazipur Variations were observed among the lines for all the characters studied except no. of seed/siliqua. Maturity duration ranged from 85-94 days. Ten tested lines matured within 85-86 days.

Plant height ranged from 86-135 cm. The highest plant height was recorded in BS-15xSAU-1-1. No. of siliquae/plant ranged from 65-152. The highest no. of siliquae/plant was recorded in BS-14xSAU-1-2. No. of seeds/siliqua ranged from 12-16. Thousand seed weight ranged from 2.78-3.51 g. Seed yield ranged from 1205-2736 kg/ha. The highest seed yield recorded in BS-14xSAU-1-3 (2736 kg/ha). Considering earliness, seed yield and other yield contributing characters, five lines BS-14xSAU-1-3, BS-14xSAU-1-4, BS-6xSAU-1-1, BS-14xBS-15-10 and BS-15xSAU-1-2 were selected for the next trial.

Preliminary yield trial of *Brassica rapa* (Set-I)

Eighteen lines of Brassica rapa having yellow seed coat colour along with two checks as BARI Sarisha-14 and Tori-7 were evaluated at Gazipur, Rahmatpur and Comilla. Significant variations were observed for all the characters studied except days to maturity. Maturity duration ranged from 84-88 days. Plant height ranged from 70-94 cm. The lowest plant height was recorded in Tori-7. No. of siliquae/plant ranged from 46-89. The highest no. of siliquae/plant was recorded in BC 100 614 (4)-3. No. of seeds/siliqua ranged from 14-26. The lowest no. of seeds/siliqua was recorded in Tori-7. Thousand seed weight ranged from 3.30-3.95 g. The highest 1000-seed weight was recorded in check variety BARI Sarisha-14 which was statistically similar with other three tested lines. Seed yield ranged from 1646-2866 kg/ha. All the tested lines showed statistically identical seed yield except check variety Tori-7.

Significant variations of genotypes x locations interactions were observed for days to maturity and seed yield over locations. Regarding maturity duration over locations, days to maturity ranged from 83-86 days. Seed yield ranged from 1457-2219 kg/ha over locations. The line BC - 100614(4)-5 produced the highest seed yield over locations and it also produced the highest seed yield at Rahmatpur and Comilla locations. Considering earliness, seed yield and other yield atributing characters, four lines like BC - 100614(4)-5, BC - 100614(4)-4, BC - 100614(4)-6 and BC - 100614(4)-8 were selected for RYT in the next year.

Preliminary yield trial of *Brassica rapa* (Set-II)

Eighteen lines of *Brassica rapa* having yellow seed coat colour along with two checks as BARI Sarisha-14 and Tori-7 were evaluated at Gazipur, Ishurdi and Jessore All the characters studied showed significant variation. Maturity duration ranged from 84-88 days. Line BC 11506 (3)-2 was the latest in maturity. Plant height ranged from 77-107 cm. The lowest plant height was recorded in BC 110714 (7)-4. No. of siliquae/plant and no. of seeds/siliqua ranged from 60-125 and 12-26, respectively. The highest no. of siliquae/plant was recorded in BC 11219315 (8)-1. The highest no. of seeds/plant was recorded in BC 100 614 (4)-19. Thousand seed weight ranged from 2.91-4.11 g. Seed yield ranged from 1457-2479 kg/ha. The highest seed yield was recorded in BC 100 614 (4)-20 (2479 kg/ha).

Significant variations of genotypes x locations interactions were observed for days to maturity and seed yield over locations. Regarding maturity duration over locations, days to maturity ranged from 81-86 days. Seed yield ranged from 1341-2063 kg/ha over locations. The line BC-100614(4)-20 produced the highest seed yield at both Gazipur and Jessore locations and over locations. Considering earliness, seed yield and other yield attributing characters, four lines like BC-100614(4)-20, BC-100614(4)-18, BC-100614(4)-19 and BC-110714(7)-3 were selected for RYT in the next year.

Regional yield trial of *Brassica rapa*

Seven lines of Brassica rapa along with BARI Sarisha-14 and Tori-7 as checks were evaluated at Gazipur, Jamalpur, Ishurdi, Jessore, Hathazari and Rahmathpur for seed yield and yield contributing characters. Significant variations were observed among the lines for all the characters studied. Maturity duration ranged from 83-87 days. Check varieties BARI Sarisha-14 and Tori-7 were matured within 85 days. Plant height ranged from 83-97 cm. The lowest plant height was recorded in Tori-7. No. of siliquae/plant and no. of seeds/siliqua ranged from 66-119 and 15-32, respectively. The highest no. of siliquae/plant was recorded in Tori-7 which was statistically similar with BARI Sarisha-14. The highest no. of seeds/siliqua was recorded in BC 100 614 (4)-9 which was statistically similar with BARI Sarisha-14. The lowest no. of seed/siliqua was recorded in Tori-7. Thousand seed weight ranged from 2.65-3.91 g. The highest thousand seed weight was recorded in BC 110 714 (7)-2 and the lowest in Tori-7. Seed yield ranged from 1615-2426 kg/ha. The highest seed yield was recorded in BC 100 614 (4)-7 which was statistically similar with other three tested lines and check variety BARI Sarisha-14. The lowest seed yield was recorded in check Tori-7.

No significant variation of genotypes x locations interaction for days to maturity and seed yield was observed over locations. Regarding maturity duration over locations, days to maturity ranged from 80-85 days. Check variety BARI Sarisha-14 and Tori-7 were the earliest in maturity (82days and 80 days, respectively) over locations. Tested lines matured within 83-85 days over locations. Seed yield ranged from 1391-2011 kg/ha over locations. The line BC-100614(4)-7 produced the highest seed yield over locations and it also produced the highest seed yield at Joydebpur, Rahmatpur and Hathazari locations. Check variety Tori-7 produced the lowest seed yield over locations. Considering earliness, seed yield and other yield attributing characters, three lines like BC-100614(4)-7, BC-100614(3)-1and BC-100614(4)-9 were selected for Adaptive Trial in the next year.

Hybridization in *Brassica* spp

Crop production can be improved by breeding new varieties of crops having higher yield. The main aim of plant breeding is to produce new crop varieties superior to the existing ones. The most frequently employed plant breeding technique is hybridization. The aim of hybridization is to bring together desired traits found in different plant lines into one plant line via crossing.

Confirmation of F_1 generation

Seed from 60 cross combinations from *B. napus* were separately harvested and were bulked cross wise for growing The seeds were sown on the 08-11-15. Each entry was grown in a single row of 2 m long plot with spacing 40 cm and 10 cm between row and plant respectively along with their parents as check. Five competitive plants were randomly selected from each parents and F_1 plots for data collection.F_1 generation. Six hybrids were confirmed and selected for growing as F_2 in the next generation. F_1 progenies were harvested, bulked and seeds were preserved to grow F_2 population in next generation.

Evaluation of segregating generation (F_2-F_6) of *B. napus*

Seeds of F_2-F_6 were sown on the8th November, 2015. All seeds were space planted in 4m long four rows with 30 cm row spacing. Recommended fertilizers were applied and necessary steps were taken to grow the crop uniformly. Desirable populations on the basis of phenotypic performance, maturity, disease reaction, physical grain quality were selected for advancing the generation.

Observation yield trial of *Brassica napus*

An observational yield trial of Brassica napus was conducted with 61 genotypes at RARS Jamalpur during Rabi, 2015-2016 to evaluate the yield and yield contributing characters. The results revealed that the highest yield was recorded from the genotype Nap-15025. It produced 1982 kg/ha yields which is 22.9% higher than check variety BARI Sarisha-8. It took 79 days to mature. The second highest yield was recorded from Nap-15028. It produced 19.4% higher yield than BARI Sarisha-8 and took 79 days to mature. The third highest yield was recorded from Nap-15024. It produced 1830 kg/ha yield and it was 13.4% higher than check variety. It only took 80 days to mature. These three lines produced higher yield and took 79-80 days to mature. These lines are suitable for growing in between Taman and Boro rice. There were some lines which produced higher yield than BARI Sarisha-8 and they became mature below 81 days. These lines may simultaneously be selected with the high yielding lines with early maturity for evaluation in preliminary yield in next year.

Nap-15025 produced the highest seed yield among the genotypes included in this trial followed by Nap-15028 and Nap-15024. Nap-15025, Nap-15028, Nap-15024 and those lines took below 81 days to mature and produced more than 1500kg/ha yield might be used in preliminary yield trial in next season.

Preliminary yield trial of *Brassica napus*

Preliminary yield trial of Brassica napus was conducted with 15 genotypes at RARS Jamalpur and Oilseed Research Centre, Gazipur during rabi, 2015-2016 to evaluate the yield and yield contributing characters. At RARS, Jamalpur, the highest grain yield was recorded from Nap-14177 (1872 kg/ha) which was 8.61% over check variety BARI Sarisha-8. It took 81days to mature. Primary branches, number of seed/siliqua were also high. Nap-14186 & Nap-14170 produced 8.24% & 0.83% higher yield over existing *napus* variety BARI Sharisa-8. They took 79 days to mature and had good number of seed/siliqua. At Gazipur, the highest yield was produced by Nap-14120. It took 87 days to mature whereas Nap-14186 and Nap-14054 took 87 and 86 days to mature.

Regional yield trial of *Brassica napus*

A regional yield trial of *Brassica napus* L. was conducted with 12 genotypes at RARS Jamalpur, RARS hathazari, RARS Ishurdi, RARS Jessor and ORC, Gazipur during rabi 2015-2016 to evaluate for yield and yield contributing characters.

At Jamalpur, the highest yield was produced by the genotype Nap-10017. It produced 1810 kg/ha yield, which was 5.0% higher yield than existing *Brassica napus* variety BARI Sarisha-8. It took 81 days to mature. The second yield was produced by Nap-10007. It produced 0.24% higher yield than check variety BARI Sarisha-8. It also took 80 days to mature. At Gazipur, Nap-10014 produced the highest yield. At Hathazari, Nap-11008 produced the highest yield. At Ishurdi, Nap-10007 produced the highest yield. At Jessor, Nap-10015 produced the highest yield. Nap-10007 produced the highest yield over the location. It produced 1814 kg/ha yield which was 13.37% higher than BARI Sarisha-13 and took 86 days to mature. Nap-11008 produced the second highest yield. It was 6.87% higher than BARI Sharisa-13 and took 86 days to mature. Nap-10009 produced 1680 kg/ha yield. It was 5.0% higher yield than BARI Sarisha-13 and took 86 days to mature. Nap-10007, Nap-10009 and Nap-11008 may be selected for adaptive trial in the farmers' field in the next season.

Evaluation of segregating generation of *Brassica juncea*

A total of 169 plants from fifteen cross combinations having brown seed coat colour and 25 plants from two cross combinations having yellow seed coat colour were selected in F_6 generation (Set-I). A total of 66 progenies out of 78 from three cross combinations having black/brown seed coat colour were selected and 27 progenies from three cross combinations having yellow seed coat colour were selected in F_6 generation (Set-II). Plants were selected considering erect and compact plant type, seed colour, seed size and siliqua shape. Harvested seeds from selected plants and progenies were stored for evaluation in the next year.

F_6 generation (Set-I)

Progenies of fifteen cross combinations having brown seed coat colour and two cross combinations having yellow seed coat colour were evaluated in F_6 generation (Set-I) during 2015-16 at Gazipur. Progenies were sown following progeny to row method along with BARI Sarisha-11 as check. Seeding of progenies was done on 16 November 2015 in 3m long of 3-rows-plot with spacing 30cm and 5cm between rows and plants, respectively. Single plant selection among the progenies was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

Single plant selection method was followed. A total of 169 plants from fifteen cross combinations having brown seed coat colour and 25 plants from two cross combinations having yellow seed coat colour were selected considering erect and compact plant type, seed colour, seed size and siliqua shape. Seeds from selected plants according to cross combinations were harvested in bulk. Seeds were stored for evaluation in Observation Trial in the next year.

F_6 generation (Set-II)

Three cross combinations having black/brown seed coat colour and three cross combinations having yellow seed coat colour were evaluated during 2015-16 at Gazipur. Progenies were sown following progeny to row method along with BARI Sarisha-11 as check. Seeding of progenies of different cross combinations was done on 16 November 2015 in 3m long of 3-rows-plot with spacing 30cm and 5cm between rows and plants, respectively. Single plant selection among progenies was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

Single plant selection method was followed. A total of 78 progenies from three cross combinations having black/brown seed coat colour were evaluated and 66 progenies were selected. Twenty seven progenies from three cross combinations having yellow seed coat colour were evaluated and selected. Plants were selected considering erect and compact plant type, seed colour, seed size and siliqua shape. Harvested seeds from selected plants were bulked according to progenies. Seeds were stored for evaluation in the next year.

Evaluation of f_2 generation of *Brassica juncea*

A total of 5 parental lines from 10 cross combinations were evaluated. Seeds were sown on November 17, 2015 in 3 meter long 2 rows plot along with their parents as check at Ishurdi.

A total of 160 single plants were harvested separately from the mention cross combinations considering yield per plant and seed coat color. Fifty six single plants out of 160 were selected finally which will be grown to advance generation from F_2 to F_3.

Observation trial of *Brassica juncea*

Seventeen lines of *Brassica juncea* along with checks as BARI Sarisha-11 and BARI Sarisha-16 as checks were evaluated under Observation Trial of *Brassica juncea* at Gazipur during 2015-16. The lines were sown on 11 November 2015 in 3 rows of 3m long with spacing of 30 cm and 5 cm between rows and plants, respectively. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Znic Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Maturity duration ranged from 102-106 days. BJ-2014(Y) 05 was the earliest in maturity (102 days). Seed yield ranged from 1103-2440kg/ha. The highest seed yield recorded in BARI Sar-11 (ch) and followed by BJ-2014B11. Considering earliness, seed yield and other yield contributing characters, four lines BJ-2014B17, BJ-2014B14, BJ-2014B11 and BJ-2014(Y) 05 were selected for the next trial.

Preliminary yield trial of *Brassica juncea* L.

Thirteen lines of *Brassica juncea* having yellow seed coat colour except one along with check BARI Sarisha-11 were evaluated at Gazipur, Ishurdi, Jessore and Hathazari during rabi 2015-16. The experiment was laid out in randomized complete block design with two replications. The plot size was 3m x 1.2m. Seeding was done on 11 November at Gazipur, 15 November at Jessore ,04 November at Ishurdi and 11 November at hathajari 2015 in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Znic Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height in cm, no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare. The data were analyzed statistically.

Maturity duration ranged from 103-106 days at Gazipur location. Seed yield ranged from 1322-2685 kg/ha at Gazipur location and the highest seed yield was recorded in Bj-53611(12)-8. Maturity duration over locations ranged from 105-107 days. Seed yield ranged from 1538-2095 kg/ha over locations. The highest seed yield was recorded in BJ-1111536(9)-6 over locations. Consudering seed yield and other yield contributing characters, four lines like BJ-53611(12)-8, BJ-1111110(12)-1, BJ-1111536(12)-6 and BJ-1111536(9)-6 were selected for evaluation in RYT.

Regional yield trial of *Brassica juncea* L.

Seven advanced lines of *Brassica juncea* along with BARI Sarisha-11 and BARI Sarisha-16 as checks were evaluated at Gazipur, Jamalpur, Ishurdi, Jessore, Hathazari and Rahmatpur during rabi 2015-16 in randomized complete block design with three replications. Seeding was done on 10 November at Gazipur, 04 November at Ishurdi, 15 November at Jessore, 15 November at Rahmatpur and 11 November at Hathazari, 2015 in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Znic Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height, no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare. The data were analyzed statistically.

Maturity duration ranged from 102-104 days at Gazipur location. Seed yield ranged from 1189-1968 kg/ha at Gazipur location and Bj-1111536(7)-1 produced the highest seed yield. Maturity duration over locations ranged from 104-105 days. Seed yield ranged from 1529-1798 kg/ah over locations. The line BJ11111111(7)-7 produced the highest seed yield (1798 kg/ha) followed by BJDH-05 (1773kg/ha) over locations. Considering location wise seed yield and other yield contributing characters, three lines BJDH-05, BJ-11111111(7)-1 and BJ-11111111(7)-7 were selected for Adaptive Trial in the next year.

Growing of F_2 and BC_2 generation of interspecific hybridizaton between *B. carinata, B. rapa* and *B. napuus*

Attempt of interspecific hybridization have been done to incorporate desirable characters from B. carinata species into the existing varieties developed by ORC. Eight F_2 cross combinations and 3 BC_2 of interspecific hybridizations were used in the experiment. Seeds of different samples were sown on 3 November 2015. *B. carinata* was late in flowering while the *B. rapa* and *B. napus* varieties were early flowering.

From the results it was found that, the days to flower as well as days to maturity of back cross generation was less compared to the F_2 segregating generation in *B. carinata* with Tori-7. The seed yield of single plants of back cross generation were 5.9-16.94 g while in F_2, it was 6.21-27.53 g and in Tori-7 was 4.1- 8.28 g. The Alternaria leaf blight was also less appeared in the back cross and F_2 generations compared to the susceptible Tori-7. From the crosses of *B. napus* with *B. carinata* single plants of 7 entries were selected and made the single plants bulk. The selected 7 entries produced higher seed yield compared to the parents BARI Sarisha-13. These entries will be included in the next in the observation trial along with their respective parents.

Maintenance of CMS, maintainer and restorer lines of *Brassica napus*

The experiment consisted of four CMS lines like $CMSZ_1$ (248), $CMSZ_2$ (279), $CMSY_2$ and $CMSY_{10}$, two maintainer lines like Nap-248M and Nap-279M and one restorer line, Nap-14-01R. It was conducted at Gazipur during rabi 2015-16. Unit plot size was two rows two meter long. Seeding was done on 15 November 2015. CMS lines were crossed with maintainer lines. Maintainer lines and restorer line were selfed. Bagging was done to protect out crossing. Crossing and selfing were done by hand pollination.

Results on crossing (CMS x maintainer line) for maintenance of CMS lines showed that, days to flowering and maturity for CMS lines ranged from 23-28 days and 105-122 days, respectively. In total 1063 buds of 57 plants of four CMS lines were crossed with two maintainer lines. Two thousand five hundred and ninety seeds were obtained from 572 siliquae. Seeds were stored for future breeding programme.

Results on selfing for maintenance of maintainer and restorer lines showed that, days to flowering and maturity for Nap-248M and Nap-279M were 24-25 days and 102 days, respectively. Flowering and maturity duration for Nap-14-01R were 30 and 121 days, respectively. One thousand seven hundred and sixty seven buds were selfed from 125 plants. In total 4632 seeds were obtained from 1132 siliquae. Seeds were stored for future breeding programme.

Development of hybrid variety in rapeseed

Hybrid seeds of Golden Sapphire of *Brassica rapa* L. imported from India received from Supreme Seed Company and Yunyouzaerhao-2 and Yunyouzaerhae-10 of *Brassica napus* L. collected from China were used as experimental material in this experiment. Pollen fertile plants in S_2 population were selfed for advancing S_3 generation.Three CMS lines $CMSZ_1$(248), $CMSY_2$ and $CMSY_{10}$ were crossed with selected plants of Restorer line Nap-2014-01R to develop test crosses. After evaluation, pollen fertile plants ranged from 54-100% and CMS plants ranged from 0-46%. In another crosses, pollen fertile plants ranged from 75-100% and CMS plants ranged from 0-25%. Four test cross hybrids, $CMSZ_1$ (248) x P_4, $CMSZ_1$ (248) x P_6, $CMSY_2$ x C_3 and $CMSY_{10}$ x C_8 showed better performance. Seeds of better hybrids were increased for further evaluation in the next year. Long duration CMS and restorer lines were back crossed with short duration *Brassica napus* lines, and BARI Sarisha-8 and BARI Sarisha-13 to develop short duration parental lines. Seeds were stored for again back crossing in the next year.

I. Identification of parental lines in *Brassica rapa* L.

Hybrid seeds of Golden Sapphire of *Brassica rapa* L. which was imported from India received from Supreme Seed Company were used as experimental material in this experiment. The experiment was conducted during rabi 2015-16 at Gazipur. S_2 seeds were obtained from hybrid seed (S_0) of this hybrid variety through selfing during last rabi 2012-13 and 2013-14. S_2 seeds were sown on 12 November 2015 for growing S_2 population. Anthers in flowers were observed visually. Plants having prominent anthers along with pollen grain in flowers were identified as pollen fertile plants. On the other hand, plants having absent of anthers or rudimentary anthers without pollen grain in flowers were identified as CMS plants. Actually CMS plants were not identified in S_2 population. Pollen fertile plants in S_2 population were selfed for advancing S_3 generation. Bagging was done to protect out crossing. Selfing was done by hand pollination.

All of the plants in S_2 population of hybrid ‘Golden Sapphire’ were identified as pollen fertile plants. Flowering ranged from 20-22 days and maturity ranged from 93-95 days. Seven hundred and ninety five buds were selfed from 90 plants. In total 494 siliquae were obtained from which 5826 seeds were obtained. Seeds were stored for advancing S_3 generation.

II. Identification of parental lines in *Brassica napus* L.

Hybrid seeds of Yunyouzaerhao-2 and Yunyouzaerhae-10 of *Brassica napus* L. which were collected from China were used as experimental material in this experiment. The experiment was conducted during rabi 2015-16 at Gazipur. S_2 seeds were produced from hybrid seed (S_0) of these two hybrid varieties through selfing during last rabi 2013-14 and 2014-15. S_2 seeds were sown on 12 November 2015 for growing S_2 population. Anthers in flowers were observed visually. Plants having prominent anthers along with pollen grain in flowers were identified as pollen fertile plants. On the other hand, plants having absent of anthers or rudimentary anthers without pollen grain in flowers were identified as CMS plants. Pollen fertile plants in S_2 population were selfed for advancing S_3 generation. CMS plants were crossed with restorer line.

During rabi 2013-14, four CMS plants were identified in plant population of hybrid Yunyouzaerhao-2 and two in plant population of hybrid Yunyouzaerhae-10. CMS plants were crossed with selected pollen fertile plants (male parent) and selected pollen fertile plants (male parent) were selfed. Similar work was done during rabi 2014-15. Crossing seeds (CMS x male parent) and selfed seeds (male parent) were sown on 12 November 2015 side by side. Data on total no. of plants, no. of pollen fertile plants and no. of CMS plants were recorded from plants of crossing seeds (CMS x male parent). CMS plants were again crossed with male parents and male parents were again selfed. Bagging was done to protect out crossing. Selfing and crossing were done by hand pollination.

Almost all of the plants in S_2 population of hybrids ‘Yunyouzaerhao-2’ and ‘Yunyouzaerhae-10’ were identified as pollen fertile plants. Results on selfing of pollen fertile plants in S_2 population of hybrids, days to flowering and maturity ranged from 21-22 days and 110-112 days, respectively for Yunyouzaerhao-2 and days to flowering and maturity ranged from 22-24 days and 112-115 days, respectively for Yunyouzaerhae-10. Two thousand eight hundred and eighty two buds were selfed from 102 plants. In total 1009 siliquae were obtained from which 10364 seeds were obtained. Seeds were stored for advancing S_3 generation.

Results on crossing between CMS plants and selected pollen fertile plants (male parent) of hybrids 'Yunyouzaerhao-2' and 'Yunyouzaerhae-10' showed that, pollen fertile plants ranged from 70-100% and CMS plants ranged from 0-30%.

Sixteen CMS plants in Yunyouzaerhao-2 were crossed with pollen fertile plants (male parent) and 59 siliquae obtained from which 576 seeds were obtained. Twenty two pollen fertile plants (male parent) in Yunyouzaerhao-2 were selfed and 257 siliquae obtained from which 2283 seeds were obtained. In case of Yunyouzaerhae-10, nineteen CMS plants were crossed with pollen fertile plants (male parent) and 117 siliquae obtained from which 1031 seeds were obtained. Fifteen pollen fertile plants (male parent) in Yunyouzaerhao-10 were selfed and 116 siliquae obtained from which 1165 seeds were obtained. Seeds were stored for growing in the next year.

III. Evaluation of test cross hybrids in *Brassica napus* L.

Three CMS lines $CMSZ_1$(248), $CMSY_2$ and $CMSY_{10}$ were crossed with selected plants of Restorer line Nap-2014-01R during last rabi 2014-15 and hybrid seeds were obtained. Selected plants of Restorer line were selfed. Hybrid seeds and selfed seeds of selected plants of restorer line were sown on 15 November during rabi 2015-16 at Gazipur. Unit plot size was one row of 3m long in both cases.

Results on test crosses between $CMSZ_1$ (248) x Nap-2014-01R showed that, days to flower and maturity for test crosses ranged from 20-23 days and 95-100 days, respectively. Pollen fertile plants ranged from 54-100% and CMS plants ranged from 0-46%. Test cross hybrids $CMSZ_1$ (248) x P_4 and $CMSZ_1$ (248) x P_6 showed better performance compared to others. Hybrid seeds of those two hybrids were produced for large plot evaluation in the next year.

Results on selfing of selected plants of restorer line of test crosses [$CMSZ_1$ (248) x Nap-2014-01R] showed that, days to flower and maturity of selected plants of restorer line ranged from 24-25 days and 120 days, respectively. Four to seven plants were selfed from each row and 40-210 buds were selfed from these rows from which 112- 554 seeds were obtained. Selfed seeds of selected plants were stored for evaluation in the next year.

IV. Development of test crosses in *Brassica napus* L.

Three CMS lines [$CMSZ_1$(248), $CMSY_2$ and $CMSY_{10}$, selected plants (P_4, P_6, C_3 and C_8) of Restorer line (Nap-14-01R) and one line (Nap-279) were used as experimental materials. The experiment was conducted during rabi 2015-16 at Gazipur. Seeds of selected plants (P_4, P_6, C_3 and C_8) of restorer line and line (Nap-279) were sown on 15 November 2015 following plant to row method. CMS lines were crossed with selected plants of restorer line and restorer lines were selfed. Bagging was done to protect out crossing. Crossing and selfing were done by hand pollination.

Two hundred and twenty one and 108 buds of $CMSZ_1$ (248) were crossed with the pollen of P_4 and P_6 plants, respectively and 465 and 248 seeds were obtained. Simultaneously, P_4 and P_6 plants were selfed and 508 and 433 seeds were obtained, respectively. Again, 34 and 65 buds of $CMSY_2$ and $CMSY_{10}$ were crossed with the pollen of C_3 and C_8 plants, respectively and 64 and 129 seeds were obtained. Simultaneously, C_3 and C_8 plants were selfed and 285 and 488 seeds were obtained, respectively. Seeds were stored for evaluation of test crosses in the next year.

For development of test crosses ($CMSY_2$/$CMSY_{10}$ x Nap-279) one hundred twenty three and 288 buds of $CMSY_2$ and $CMSY_{10}$ were crossed with the pollen of Nap-279, respectively and 290 and 467 seeds were obtained. Simultaneously, Nap-279 line was selfed for maintenance. Seeds were stored for evaluation of test crosses in the next year.

V. Development of short duration parental lines in *Brassica napus* L.

Two CMS lines, $CMSZ_1$ (248) and $CMSZ_2$ (279), one Restorer line, Nap-14-01R, three short duration (87-88 days) *Brassica napus* lines, Nap-0876, Nap-0869 and Nap-205, two varieties, BARI Sarisha-8 and BARI Sarisha-13 (93-95 days) and one *Brassica napus* line, Nap-14-015 were used as experimental materials. The experiment was conducted during rabi 2015-16 at Gazipur. Seeds were sown on 15 November 2015. CMS lines were crossed with three short duration *Brassica napus* lines, and BARI Sarisha-8 and BARI Sarisha-13. Restorer line was crossed with BARI Sarisha-8 and BARI Sarisha-13 and Nap-14-015. Bagging was done to protect out crossing. Crossing was done by hand pollination.

Days to maturity for CMS lines ranged from 100-101 and for *Brassica napus* lines/varieties ranged from 87-95 days. One thousand six hundred and eighty three buds of 94 CMS plants were crossed with short duration *Brassica napus* lines/varieties. Six hundred and forty nine siliquae was obtained from which 2889 seeds were obtained. Seeds were stored for back crossing in the next year.

Identification of early restorer genes in *Brassica napus*

An attempt has been taken to develop hybrid *B. napus* variety. The experiment was conducted using four BC_2, $9F_2$ and 2 CMS with their respective parents. The collected restorer was very late in flowering. The F_2 generation was advanced for F_3 through bud selfing and BC_2 was also advanced as S_1 generation.

The parental lines A and B were almost synchronumous in flowering and maturity. Original restorer (R) is very late both in flowering (55 days) and maturity (155 days) compared to the parental lines A (31-32 days) and B (28-30 days). The days to flower and maturity of newly developed restorer (BC_2) were (31-36 days) and (109- 113 days) respectively almost synchronize with the A and B lines.

Regional yield trial of double low genotypes of *Brassica napus* L.

Six genotypes of *Brassica napus* along with BARI Sarisha-14 and Tori-7 as checks were evaluated at Gazipur during rabi 2015-16 to know the performance of the genotypes and to develop ‘double low’ (Canola) variety. The genotypes were sown on 08 November 2015 in 3 rows of 3m long with spacing of 30 cm and 5cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Znic Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha. Fatty acid composition and glucosinolate of the genotypes were determined at the Central Laboratory to identify ‘double low’ genotypes of *Brassica napus*. Data were also taken on oleic acid, linoleic acid, linolenic acid, erucic acid and glucosinolate.

Maturity duration ranged from 85-102 days. Although check varieties Tori-7 and BARI Sarisha-14 matured earlier (85-88 days) but tested genotypes took 99-102 days for maturity. Seed yield ranged from 1544-2948 kg/ha and the genotype BN-1411 produced the highest seed yield (2948 kg/ha). The tested genotypes showed erucic acid ranged from 0.08 to 2.86% and glucosinolate ranged from 8.705 to 15.560 (µmol/g DW). Considering seed yield and other yield contributing characters, low erucic acid and low glucosinolate, genotype BN-1411 was selected for release as a ‘double low’ (Canola) variety.

Crop Management

Performance of selected mustard genotypes under salinity condition in pot culture

The experiment was conducted during the period from November, 2015 to January 2016 in the net house of Oilseed Research Centre, BARI, Gazipur. The genotype BD -10108, BD -7115, BD -7104, BD -6957, BD -10112, BD -10111, BD -6950, BD -7114 and BD -10115 screened in laboratory under hoagland nutrient solution culture were used in the study at control, 4,8 and 12 dS/m of NaCl solution. The study was carried out in completely randomized design under factorial arrangement with three replications. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 4, 8 and 12dS/m solution. Soil pH value was recorded in two days interval. The root and shoot sample were collected prior to harvest. The collected sample was oven dried at 80^0 C for 72 hours. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2 mm mesh sieve. The yield and yield component data were collected from five randomly selected plants from each treatment at harvest. Data were analyzed following Cropstate program and means were compared using LSD test.

Genotypes were greatly influenced by salinity with respect to root dry weight, shoot dry weight, days to flowering, days to maturity and yield over control. Among the nine genotypes. BD -7114, BD -10111, BD -10115 and BD-6957 showed more salt tolerance at 12dS/m the salinity level in respect of root-shoot growth and yield performance.

Performance of selected rapeseed-mustard genotypes under salinity condition in coastal area

The experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2015-16 to select salt tolerant mustard genotype under salinity condition. There were eight varieties/genotypes namely *Brassica campestris*: SAU-01, *Brassica napus*: Nap-0564, Nap-0567, BARI Sarisha-8; *Brassica juncea*: BJDH-12, Jun-536, BARI Sarisha-11and BARI Sarisha-16 following RCB design with three replications. Unit plot size was 1 m × 1 m. Seeds were sown in 10 November, 2015 in row to row distance of 30 cm. At every 7 days interval soil salinity (dS/m) was measured by EC meter (HANNA: HI 9835).

The highest seed yield (2.15 t/ha) was recorded in BARI Sarisha-16 with higher BCR (2.36) and lowest seed yield (1.44 t/ha) was recoded in Nap-0567. The lowest level (3.80 dS/m) of soil salinity was recorded in the sowing time and the highest level (10.62 dS/m) was in the harvesting stage. Among the eight genotypes Jun-536, BARI Sarisha-11and BARI Sarisha-16 showed more salt tolerance at all the salinity levels in respect of root-shoot growth and yield performance

Effect of different type of mustard variety in mustard- boro mixed cropping system

A field experiment was conducted at MLT site, Debiddar and Chandpur during rabi season of 2015-16 to find out the suitable mustard variety in Mustard- Boro mixed cropping system and to calculate the cost and return of mixed cropping system in Comilla region. The experiment laid out in RCB design with 5 dispersed replications. Four different treatments i.e T_1= 100 % Boro rice (Var. BRRI dhan29) + 100 % BARISarisha-9, T_2 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-14, T_3 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-15, T_4 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-17 were used in the experiment. The experiment was laid out in Randomized Complete Block design with five dispersed replications. All materials of the treatments were applied following broadcasted method. The experiment was set on 9th November 2015 Mustard was harvested on 04-06 February 2016, whereas boro rice on 24-26 April, 2016. Data on the different crop parameters were collected from the 10 sample plants and then average was taken.

Cost and return analysis revealed that the combination of BRRI dhan29 plus BARI Sarisha-17 (T_4) gave the highest gross return (Tk.134850 ha^{-1}), gross margin (Tk. 62310 ha^{-1}) and benefit cost ratio (1.87) as compared to the other mixed cropped combinations

Pest management

Screening of rapeseed-mustard varieties/lines against *alternaria* blight

The experiment was conducted at Oilseed Research Centre, BARI, Gazipur during rabi 2015-2016 cropping season to findout the resistant lines of rapeseed-mustard against Alternaria blight. Thirty one (31) lines of different *B. campestris, B. napus* and *B. juncea* were used in the study. Seeds were sown on 11 November 2015 with three replications. A susceptible line Tori-7 was used in the experiment as infector. Every test lines were sown in two rows of 2 m long separated by single row of susceptible infector (Tori-7). Disease data were recorded at 60-65 days after sowing. Severity of leaf blight and yield were recorded. *Alternaria* Blight of mustard scored according to 0-5 scale. The scale was 0= leaves free from leaf spot (HR), 1= 0.1-6% leaf or pod area diseased (R), 2= 6.1-12% leaf or pod area diseased (MR), 3= 12.1-25% leaf or pod area diseased (MS), 4= 25.1-50% leaf or pod area diseased (S) and 5= above 50% leaf or pod area diseased (HS).

Among the 31 test lines; only three varieties /lines (Nap-205, BJ-66(y) and BARI Sarisha-11) were resistant to the disease. Nineteen lines(NAP-10015,NAP-1005, NAP-1007, NAP-10014, NAP-10012- 1, BARI Sarisha 13, NAP-11008, NAP-10009, NAP-10017, BC-05115, 05118,BC-100614(4)-9,BC-100614(7)-2,BJDH-05, BJDH-20 ,BJDH-01, BJ-1111536, BJ-1111536(12)-1 and BJ-1111536(12)-5 showed moderately resistant reaction to the disease. Rest of the lines showed moderately susceptible to susceptible reaction. These *resistant* lines can be used as breeding materials for development resistant variety.

Screening of rapeseed-mustard lines for resistance to *OROBANCHE*

An experiment was laid out at Regional Agricultural Research Station, Ishurdi, Pabna during 2015-2016 to find out the resistant lines of rapeseed-mustard against Orobanche. Among the 31 oilseed Brassica germplasms nine lines/varieties viz. BARI-11, BARI-16, BC-110614-7-6, BC-110714(9)-5, BC-100614(4)-12, BC-100614(4)-7, BC-100614-4-19, BC-100614-4-2 and BC-100614(4)-5 showed resistant reaction, 5 lines showed moderately resistant reaction and the rest of 17 lines including check showed susceptible reaction against Orobanche.

Integrated management of *alternaria* blight of rapeseed-mustard

The study was conducted at ORC Gazipur, during 2015-2016 cropping season to find out the suitable management practice in controlling leaf blight of mustard. .The experiment was designed in RCB with 3 replications where plot size was 3m x 2m. Seven treatments were used in this study. The treatments were: T_1 = Seed treatment (ST) with provax 200 (2.5g/kg seed) + Rovral (0.2%) single spray at 55 DAS,T_2 = ST with Bavistin 70WP + Rovral (0.2%) single spray at 55 DAS,T_3 = ST with Trichoderma spp (4g/kg seed) + single spray at 55 DAS,T_4 = ST with neem leaf extract + Spray neem leaf extract (20%),T_5 = Rovral spray (recommended), T_6 = Single spray of Rovral at 55 DAS and T_7 = Control. In each plot 10 plants were ramdomly selected and tagged for data recording. Disease data were recorded before 10 days of harvest. Percent Disease Incidence (PDI), no. of pod/plant, number of seed/pod, 1000 seed weight (gm) and yield (kg/ha) were recorded. Alternaria blight of mustard was scored according to 0-5 scale developed by Meah (1994)

The lowest disease incidence (20.22%) with the highest yield (1630kg/ha) was obtained from recommended Rovral sprayed plot .The second highest yield (1561kg/ha) and second lowest disease incidence (21.33%) were obtained from seed treatment with Provax with single spray of Rovral at 55 DAS. The highest disease incidence (67.87%) and lowest yield (1038 kg/ha) were recorded from control plot. From the result it may be concluded that T_5 treatment (recommended dose of Rovral) was effective option for reducing the disease incidence and increasing the seed yield of mustard. Seed treatment with Provax+single spray of Rovral at 55 DAS could effectively decreased the disease incidence and provided higher yield and their efficacy are similar with T5 treatment (recommended dose Rovral) .

Study of fungicides against white mold disease of mustard

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during rabi season 2015-2016 to find out the effective fungicides for controlling white mould/ Sclerotinia rot disease of mustard. BARI sharisa-14 was used in this experiment. The experiment was assinged in a RCBD with three replications. The unit plot size was 3m x 3m and seeds were sown on November 17, 2014. Seven fungicides where, T_1= Rovral 50 WP (Iprodione) @2g/l, T_2= Score 250 EC (Hexaconazole) @2ml/l, T_3=Folicur 250 EC (Tebuconazole) @2ml/l, T_4=Indofil M 45 (Mancozeb) @2g/l, T_5 = Contaf 5 EC (Hexaconazole) @2ml/l, T_6=Secure 600wg (Fenamidione + Mancozeb) @2g/l, T_7 =Tilt 250EC (Propiconazole) @1ml/l and T_8= Control were used in this experiment. All the fungicides showed significantly better performance over control. The lowest incidence of white mould disease (0.95%) was found in Folicur 250 EC (2ml/l) treated plots where as the highest (11.62%) was recorded in control plots.Moreover, Folicur 250 EC (2ml/l) treated plots has provided the highest yield (1.51t/ha). From the experimental results, it may be concluded that Folicur 250 EC (2ml/l), Rovral 50 WP (2g/l) and Tilt 250EC (1ml/l) applied three times from the first appearance of the disease at an interval of 10 days showed better performances for the control of white mould (*Sclerotinia* rot) disease and increase yield of mustard.

Screening of rapeseed & mustard entries (*Brassica* spp.) against aphid (*Lipaphis erysimi* Kalt.)

Twenty six (26) entries of rapeseed and mustard were evaluated against mustard aphid (*Lipaphis erysimi* Kalt.) during rabi 2015-16 at Gazipur. Design was RCBD with three replications. Out of 12 entries of *B. rapa,* three entries namely BC-05115, BC-9921, BC-05117 (14.45-28.42 aphids/plant) and out of 14 entries of *B. juncea,* BJDH-01, BJDH-12 (6.35-8.45 aphids/plant) were attacked by less no. of aphid than the check and other entries. From the result of this experiment, it was observed that *B. rapa* entries were attacked by the highest number of aphid while *B. juncea* had the lowest aphid infestation.

Post harvest and biochemical studies

Identification of glucosinolate profiles and fatty acid composition of rapeseed-mustard varieties

The experiment was conducted in Central Laboratory, Oilseed Research Center, BARI, Gazipur during the period from November 2015 to April 2016. Rapeseed-mustard cultivars (BARI sarisha 13, BARI sarisha 11, and BARI sarisha 14) were collected from Oilseed Research Center. Glucosinolates were analyzed by high performance of liquid chromatography (HPLC) in the seeds and was carried out according to the procedure with some modifications as described by Ishida *et al.* (1997) and methylation of fatty acids profile in the oils under study was carried out according to the procedure with some modifications as described by Were *et al.* (2006).

The results of this study showed that rapeseed-mustard varieties differed their glucosinolate and fatty acid contents. Eight major GSLs were identified in rapeseed-mustard seeds belonging to the three chemical classes: aliphatic (sinigrin, progoitrin, gluconapin, glucobrassicanapin, glucoalyssin), two indolyl (4-hydroxyglucobrassicin and glucobrassicin), and one aromatic (gluconasturtiin). In seeds, aliphatic and indolyl GSLs represented between 91-95% and 1-4%, respectively. The total GSLs content in seeds 12-22 µmol/g DW. Among all varieties significant variability in fatty acids were observed. The major fatty acids were identified such as oleic acid ranged from 12-21%, linoleic acid from 15-19%, linolenic acid from 8-11% and erucic acid from 35-48%, respectively. These parameters, glucosinolate profiles, and fatty acid contents could be taken into consideration by oilseed breeders as selection criteria for developing genotypes with modified seed quality traits in *Brassica* sp.

Estimation of low erucic acid and total glucosinolates content in some rapseed-mustard cultivars in Bangladesh

The experiment was conducted in Central Laboratory, Oilseed Research Center, BARI, Gazipur during the period from August 2015 to April 2016. Sixteen lines (*Nap-14-001, Nap-14-002, Nap-14-003, Nap-14-004, Nap-14-005, Nap-14-006, Nap-14-007, Nap-14-008, Nap-14-009, Nap-14-010, Nap-14-011, Nap-14-012, Nap-14-013, Nap-14-014, Nap-14-015,* and *Nap-14-016*) of rapeseed-mustard including one check as BARI Sarisha 13 were characterized for their total glucosinolate and fatty acid composition. Glucosinolates were analyzed by high performance of liquid chromatography (HPLC) in the seeds and was carried out according to the procedure with some modifications as described by Ishida *et al.* (1997) and methylation of fatty acids profile in the oils under study was carried out according to the procedure with some modifications as described by Were *et al.* (2006).

Six advanced *napus* lines, *Nap-14-001, Nap-14-002, Nap-14-004, Nap-14-007, Nap-14-010,* and *Nap-14-011* had very low levels of total glucosinolate content (8.705-15.56 µmol/g DW), and erucic acid (1-5%) and high levels of unsaturated fatty acids than BARI sarisha 13. These six advanced lines may be exploited in breeding programs (as a canola variety) for the development of nutritionally better-quality locally adaptive cultivars.

Groundnut (*Arachis hypogaea* L.)

Varietal Development

Maintenance and evaluation of groundnut germplasm

A total of one hundred thirty nine (139) genotypes were grown in a non replicated trial at Gazipur to maintain the seeds of germplasms and evaluate the collected materials for future use in the breeding program. The sowing date was 31 December 2015. Seeds were sown in two rows of 4 m long plot with the spacing line to line 30cm and plant to plant 15 cm. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively. Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like number of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot.

The ranges for days to maturity, plant height, mature pods/plant, 100 karnel weight (g), shelling (%) and plot yield (g) were (145-189 days, 4.2-66 cm, 3-28, 22-95g, 50-90 and 20-654 g), respectively. The highest coefficient of variation (CV%) was recorded for the character plot yield (55.65) followed by mature pods/plant (35.12) and 100 karnel weight(g) (25.10), respectively. Minimum variation was observed in the character days to maturity and moderate variation was showed for the character plant height. Considering characters the mature pods/plant, plot yield and plant height 10 genotypes have been selected for growing in observation trial in the next year.

Hybridization of groundnut

Two batches of seven groundnut parental lines were sown on twelve days interval in 31 December 2015 and 13 January 2016 at Gazipur to develop high yielding varieties. The seeds of individual parents were planted in raised bed of 2 rows x 2m long with the spacing 50 and 20cm between rows and plants respectively. After the flower initiation, the crosses had been attempted. The unopened matured buds were emasculated at afternoon (12.00 pm to 2.00 pm) and the emasculated buds were pollinated in the following morning (6.00 am to 8.00 am.).

A total of 200 pods were harvested from 442 pollinated buds out of nine crosses. On an average 45% crosses were successful. The pollinated pods will be grown in the next rabi season for F_1 confirmation. The percent of success is low due to the drought prevailing at flowering stage and excessive rainfall occurred during pod filling stage.

Evaluation of segregating generations of groundnut

Seeds of ten combinations from F_1, three entries from F_2 , twenty entries from F_4 and four entries from F_6 respectively were sown on December 31, 2015 at Gazipur. Unit plot size was 4m long with required number of rows. Recommended doses of fertilizers were applied and necessary steps were taken to grow the crop uniformly.

A total of 17, 13, 87 and 13 single plants were selected from F_1 , F_2, F_4 and F_6 generations, respectively on the basis of no. of mature pods, pod bearing nature, diseases and insect resistant. Eighty seven (87) and thirteen (13) selected plant populations were bulked according to the cross combinations from F_4 and F_6 generations respectively. The seeds of segregating generation were collected and stored for advancing the generations in the next season.

Observation trial of groundnut

Eighteen genotypes including two checks as Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi 2015-2016. Seeds of the entries were sown on December 30, 2015 in RCB design with 2 replications. Unit plot size was 2 rows 4 m long with the spacing of 40cm x 15cm between rows and plants, respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively. Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like no. of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted pod yield per hectare. Recorded data were analyzed statistically.

The genotype TG 51 was most dwarf entry (42 cm) compared the check variety Dhaka-1(45 cm). Maximum shelling percent were found in the genotypes ICGV 93420 (86%), TG 51(83%) and ICGV 87073 (82%). Highest pod yield of 2047 kg/ha was obtained from the genotype TG 51 followed by the genotype ICGV 93420 (1928 kg/ha) which were 38% and 30% higher than the check variety Dhaka-1 and 18% & 10% higher than the HYV BARI Chinabadam-8, respectively. Other two entries ICGV 87073 and TG 37 also produced the 30% higher pod yield than the check variety Dhaka-1. Considering the yield and shelling percentage nine genotypes TG 51, ICGV 93420, TG 37, ICGV 87073, ICGV 02841, ISD 3814, ISD 4114, 14-203 and PK-1 were selected for PYT in the next year.

Preliminary yield trial of groundnut (Set-I)

The experiment is conducted with eleven groundnut genotypes including 2 checks as Dhaka-1 and BARI Chinabadam 8 at Gazipur, Burirhat and Ishurdi locations in a randomized complete block design with 3 replications. Unit plot size was 5 rows 4m long with the spacing of 40cm between rows and 15 cm between plants. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKSZn, respectively. Intercultural operations were done as and when necessary. Data on days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like number of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted into pod yield per hectare. Recorded data were analyzed statistically.

Significant differences were observed among the genotypes for all the characters studied at Gazipur. Maturity duration ranged was 145-152 days. The genotype NCGV 0207 was most dwarf entry (16 cm) compared to the check variety Dhaka-1 (43 cm) for character plant height. Highest number of mature pods/plant (35) was obtained by the entry NCGV 0204. The range of hundred kernel weight 24-63g which indicated the entries NCGV 0207, NCGV 0504 and NCGV 0704 were bold seeded genotype. Highest shelling percentage was recorded in the genotype NCGV 0204 (83) followed by the entries NCGV 0504 (77%) and ICGV 91176 (75%). The Genotype NCGV 0204 produced the maximum pod yield (1844 kg/ha) followed by BARI Chinabadam 8 (1760 kg/ha) and NCGV 04096 (1738 kg/ha) which were 26%, 21% and 19% higher than the check variety Dhaka-1, respectively. The genotype NCGV 0204 produced 5% higher pod yield than BARI Chinabadam-8. As this was the first year result, the trial will be repeated next year.

Regional yield trial of groundnut (Set-II)

Thirteen entries including two checks Dhaka-1 and BARI Chinabadam 8 were evaluated at Gazipur, Jamalpur, Ishurdi, Jessore, Rahmatpur and Hathazari. Seeds of different entries were sown on December 30, 2015 in a RCB design having 3 replications in Gazipur. Unit plot size was 4 rows 5 m long with the spacing 40 cm x 15 cm between rows and plants, respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively. Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like no. of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted pod yield per hectare. Recorded data were analyzed statistically.

Significant differences were observed among the varieties/lines for all the characters studied excepted days to maturity at Gazipur location . The genotypes ICGVS 35-1, ICGV-09516, ICGVS 38-3 and ICGVS 15-1 which ranged between 150-154 days more than the check Dhaka-1. Number of mature pods/plant ranged from 13-27. Shelling percentage ranged from 47-82%. Highest shelling percentage was recorded in ICGV-96346 (82%) followed by ICGVS 15-1 (78%) and ICGV-09516 (76%). The genotype ICGV-96346 produced the highest seed yield of 2001 kg/ha followed by the released variety BARI Chinabadam 8 (1766 kg/ha) and ICGV-95066 (1743 kg/ha) which were 39%, 22% and 21% higher than the check variety Dhaka-1. The genotype ICGV-96346 produced higher seed yield than released variety BARI Chinabadam-8.

Regional yield trial of groundnut (Set-1)

The experiment was conducted at Gazipur, Jamalpur and Burirhat during rabi 2015-2016 with 16 promising genotypes of groundnut including 3 checks Dhaka-1, BARI Chinabadam-8 and BINA Chinabadam-4. All the genotypes were collected from ICRISAT, India. The experiment was laid out in Randomized Complete Block design having three replications. The plot size was 4m x 1.6m. Seeds were sown on the December, 2013 in 15cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on, days to maturity, mature pods per plant, 100 kernel weight, immature pod per plant, shelling % and yield per plot. The plot yield was converted into kg per hectare. The data were analyzed statistically.

Shelling percent was the highest in the genotype ICGV-00338 (85) followed by ICGV-06237 (83%), ICGV-02005 (81%), ICGV-02038 (80%), ICGV-07220 (79%), ICGV-07219 (79%), BINA Chinabadam-4 (79%), ICGV-06423 (77%) and ICGV-06285 (75%) indicating the bold seeded of groundnut. The genotypes ICGV-00338, ICGV-07219 and ICGV-07220 had the highest mature pods/plant 35, 32 and 32, respectively which is a good indicator of successful seed production ability of the line. The genotypes ICGV-91114, ICGV-02005 and BARI Chinabadam 8 take more duration to maturity than the check variety Dhaka 1. The genotypes ICGV-06237 and ICGV-00338 produced the highest 100 kernel weight of 59g and 56g, respectively followed by ICGV-07219 (56g), ICGV-02038 (51g), ICGV-06285 (48g) and ICGV-07220 (47g) which is a good trait for increased seed production in groundnut. The genotype ICGV-00338 produced the higher yield of 1950 kg/ha followed by ICGV-02125 (1780 kg/ha) and the released variety BARI Chinabadam-8 (1730 kg/ha) which were 35%, 23% and 19% higher than the check variety Dhaka-1.

Crop management

Effect of storage conditions on the seed quality of groundnut stored in different containers

An experiment was conducted at the Central Laboratory of Oilseed Research Centre, BARI, Gazipur, Gazipur-1701 during the period from September 2015 to February 2016. The experiment was laid out in Complete Randomized Design (CRD) with three replications. Six storage period and five container were used in this experiment. Storage periods are i. September 15 , ii. October 15, iii November 15, iv December 15, v. January 16 and vi. February 16. Storage period commenced on 01 September 15 and data were taken in every 01 month interval noted on different physiological observations. BARIChinabadam-8 was used for the experiment. Seeds were stored in different air tight packing system viz, Plastic container, Polythene, Tin container, Gunny bag and Earthen pot at room temperature from September to February. Seed moisture content was determined by the Farmpoint Moisture Analyzer. Seeds were placed on sand media in the plastic plat every month interval. Seedlings were counted every day up to the completion of germination at ten day. The following data were recorded: a. germination % b. root length (cm) c. shoot length (cm) d. vigor index.

Results revealed that tin container showed the maximum germination capacity with high germination percentage and vigour index; which was identical to plastic and polythene where as gunny bag showed the lowest seed germination capacity during the testing period. The highest moisture content, electrical conductivity and abnormal seedlings were recorded in gunny bag; where as the lowest values of these parameters were recorded in tin container. The moisture content, electrical conductivity and abnormal seedlings were increased with advanced of storage period; but germination percentage, vigor index, oil and protein content in seed were decreased with the increase of storage periods. Among the five containers, tin container and plastic were the best and the gunny bag was the worst storage containers for groundnut seed storage for long time because the rate of moisture absorbance was higher in gunny bag than tin container, plastic container and polythene.

Effect of water stress at different growth stages on growth, yield and oil content of groundnut

The experiment was conducted in field semi controlled condition at BARI, Gazipur during 2015-16. Groundnut var. BARIChinabadam-8 and six treatments like; Control (no water stress), farmers practices(depending on rain), water stress at vegetative stage, water stress at flowering stage, water stress at pegging and water stress at pod formation were used in the study. The experiment was laid out in Randomized Complete Block Design with three replication. Seeds were sown on 19th November, 2015. Control-plants were well watered throughout the experimental period. Groundnuts were stressed for 20 days (25 days after emergence) during the vegetative stage, flowering stage to pegging stage (46 to 55days after emergence) and pod filling stage (65 days after emergence). Drought treatment was imposed by restricting irrigation and plants were re-irrigated when they showed signs of wilting or leaf rolling. For each water stress treatment, watering was with held until the plots reached a stress level of 30% of plant available water. Except for the periods of stress, the watering for all treatments was the same as that for the control plants. All measurements taken on plants were done before raring and after each stress treatment. Data collected on days to flowering, maturity, yield contributing characters, yield, total dry matter weight and reduction (%) of yield and dry matter weight which statistically analysed.

Drought stress showed reduced total dry matter (TDM), which affected growth and yield parameters as well as yield. The drought stress at flower to pegging stage had relatively greater effect on the plant growth of groundnut. The highest seed yield (2300kg/ha) was obtained from control treatment (no drought) and the lowest (1268kg/ha) from farmer's practice The control treatment gave the highest total stover yield (4056kg/ha) and the lowest (2778kg/ha) from farmer's practice . Among the different growth stages, the lowest seed yield (1268 kg/ha) and stover yield (2778 kg/ha) was obtained from flowering stage under stress condition. Maximum shelling percent (21.0%), yield (44.87%) and total dry matter (31.50 %) of groundnut (var. BARI Chinabadam -8) reduction was found at farmers practices followed by flowering stage under stress condition with shelling percentage (17.81%), yield (39.47%) and total dry matter (25.13 %) respectively.

Intercropping black cumin with groundnut

A field experiment of intercropping black cumin with groundnut was conducted in Oilseed Research Centre, Gazipur during rabi season of 2015-16 to find out the optimum row arrangement of black cumin as intercropping with groundnut for higher productivity and return. Six treatments were T_1= Sole groundnut, T_2= One row black cumin (15x10 cm) in between two normal rows of groundnut (40x15 cm), T_3= Two rows of black cumin in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of black cumin, T_5= Three rows of groundnut rows alternate with three rows of black cumin and T_6= Sole black cumin. The experiment was laid out in Randomized Complete Block Design with three replications. Both the seeds of BARI Chinabadam-8 and BARI Kalozira-1 were sown on 18 November, 2015. At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically. Yield of individual crop was converted to groundnut equivalent yield (GEY) considering prevailing market price of the crops. Benefit cost analysis were also done.

Although intercropping reduced groundnut yield but total productivity was increased due to addition of black cumin yield. Total productivity in terms of groundnut equivalent yield (GEY) (4.56 t/ha) was obtained from T_3 treatment while the lowest (2.50 t/ha) in groundnut sole crop. However, highest benefit cost ratio (BCR) (7.7) was also recorded in T_3 treatment (Two rows of black cumin in between two normal rows of groundnut).

Performance of selected groundnut genotypes in charland areas

The trial was conducted at Gopalganj Sadar, Chargobra, Gopalganj and Jamalpur during rabi season 2015-16 with nine groundnut genotypes viz. DF-090035, ICGV-97232, ICGV-95070, ICGV-96390, ICGV-1224-G-75, J1987015-SL-1, ICGV-87860-G3, ICGV-95399, ICGV-96175 and Dhaka-1 as a check to select suitable variety/lines of groundnut. The experiment was laid out in a RCB design with 3 dispersed replications. Unit plot size was 3.6 m X 4.5 m. Seeds were sown in a distance of 15 cm keeping row to row distance 35 cm apart. Date of sowing was 10 December 2015 and was harvested on 30 April to 05 June 2016.

Among the varieties/lines, the highest nut yield (2.85& 2.04 t ha^{-1}) was recorded in ICGV-96390 followed by ICGV-95070 (2.70 & 2.03 t ha^{-1}), ICGV-87860-G3 (2.55 & 1.98 t ha^{-1}) and DF-090035(2.50 &1.90t/ha) at both locations.

Pest Management

Screening of groundnut line(s) against leaf spot and rust diseases

An experiment was conducted at ORC, Gazipur during rabi 2015-2016 under natural epiphytotic condition to evaluate groundnut entries to leaf spot and rust diseases. Twenty-three entries of groundnut were evaluated under natural epiphytotic condition against leaf spots and rust diseases using infector row method. Every tested genotypes were sown in two rows of 2 m long separated by single row of highly susceptible variety Dhaka-1 as infector. Disease severity was recorded using 0-5 and 1-9 scale respectively, for leaf spot and rust 15 days before harvest the crop. Ten plants from each entry were randomly selected, tagged and harvested separately for collecting data on yield contributing characters. Leaf spot disease was scored by using 0-5 scale where 0= no infection (HR), 1= Up to 10% leaf area infection ®, 2= 11-30% leaf area infection (MR), 3 = 31-50% leaf area infection (MS), 4= 51-75% leaf area infection (S), 5= 76-100% leaf area infection (HS).Again rust disease also recorded by using 1-9 scale where, 1= no pustules visible (HR), 3= few scattered pustules, usually seen after searching®, 5= pustules common on leaves and easily observed but causing no apparent damage (MR), 7= pustules very common and damaging, few pustules on petioles and stem (S) and 9= pustules very extensive on all plant parts, some death of leaves and other plant parts (HS). Among the 25 tested lines , only one line namely ICGV-95456) showed highly resistant reaction and six lines (ICGV-00351, ICGV-34-3, ICGV-18-1, ICGV-3479-G-37, ICGV-95098, and ICGV-0104) showed resistant reaction against rust disease. Six lines namely (ICGV-00351, ICGV-34-3, ICGV-18-1, ICGV-3479-G-37, ICGV-96342 and ICGV-9390) showed resistant reaction against leaf spot. Four lines (ICGV-00351, ICGV-34-3, ICGV-18-1, and ICGV-3479-G-37) showed resistant reaction to both leaf spot and rust diseases.

Effect on the environmental factors on the severity of tikka and rust disease and yield of groundnut

The experiment was conducted at ORC, Gazipur with BARI Chinabadam-8 during rabi 2015-2016 to find out the relationship of disease development with temperature and relative humidity. The experiment was designed in RCBD with 3 replications. The treatment were: T1=seed sowing at 1 Nov, T2= seed sowing at 1 Dec, T3= seed sowing at 1 January T4= seed sowing at 1 February, T5= seed sowing at 1March T6= Seed was not shown for heavy rainfall at 1April and T7= seed sowing at 1 May. The crop was allowed to grown under natural infection condition. Disease severity was recorded using 0-5 and 1-9 scale respectively, for leaf spot and rust before 15 days of crop harvest. Ten plants from each plot were randomly selected, tagged and harvested separately for collecting data on yield contributing characters. Leaf spot disease was scored by using 0-5 scale where 0= no infection (HR), 1= Up to 10% leaf area infection ®, 2= 11-30% leaf area infection (MR), 3 = 31-50% leaf area infection (MS), 4= 51-75% leaf area infection (S), 5= 76-100% leaf area infection (HS).Again rust disease also recorded by using 1-9 scale where, 1= no pustules visible (HR), 3= few scattered pustules, usually seen after searching®, 5= pustules common on leaves and easily observed but causing no apparent damage (MR), 7= pustules very common and damaging, few pustules on petioles and stem (S) and 9= pustules very extensive on all plant parts, some death of leaves and other plant parts (HS).

It was observed that groundnut seeds sown on December to January produced higher yield with minimum leaf spot and rust disease incidence. Disease severity was increased with delay of sowing because of rising temperature and relative humidity that favorable for disease development.

Sesame

Varietal Development

Hybridization in sesame

A total of 345 buds were pollinated from 5 varieties at ORC, Gazipur. On an average 34.98% crosses were successful and produced 126 pods. Crossed seeds were collected to be grown as F_1 in the next season.

Observation trial of sesame

Elevan (11) entries including one check as BARI Til-4 were evaluated at Gazipur during Kharif season 2016. The genotype BARI Til-4 was most dwarf entry. The genotype Ses-0265 followed by the genotype BT-2xBT-3-8 produced remarkable seed yield compared to the check variety BARI Til-4. Four genotypes Ses-0265, BT-2xBT-3-8, T6xBT-2-3 and Ses-JP-21 have been selected for PYT.

Preliminary yield trial of sesame

Over two locations seed yield indicated that Ses-Jp-24 showed the highest mean yield performance at Ishurdi and Barisal followed by the genotype Ses-Jp-25. Among others entries Ses-70, Ses-5,Ses-65,Ses-0570 performed better than check BARI Til-4 at Gazipur and Ses-Jp-25,Ses-5,Ses-52,Ses-79,Ses-65 at Ishurdi. Considering all locations that Ses-Jp-24 showed the highest yield performance at Gazipur and Ishurdi followed by the genotype Ses-Jp-25. Among others entries Ses-70, Ses-5, Ses-65, Ses-0570 performed better than check BARI Til-4 at Gazipur and Ses-Jp-25, Ses-5, Ses-52, Ses-79, Ses-65 at Ishurdi. Ses-Jp-24, Ses-Jp-25, Ses-70, Ses-5, Ses-65, Ses-0570, Ses-52, Ses-79 and Ses-65 were selected for RYT.

Regional yield trial of sesame (Set-I)

Nine entries of sesame along with two checks lines of sesame along with two checks were evaluated at three locations during kharif, 2016. Over locations considering seed yield and other yield contributing characters Ses-05115, Ses-65, Ses-05178 and Ses-0570 were selected for adaptive trial. Considering seed yield and other yield contributing characters the genotype Ses-05115, Ses-65, Ses-05178 and Ses-0570 were selected for adaptive trial.

Regional yield trial of sesame (Set-II)

Nine entries of sesame along with two checks lines of sesame having white or creamy seed coat color along with two checks were evaluated at three locations during kharif, 2016. Over locations considering white seed coat color, seed yield and other yield contributing characters Ses-05163, Ses-JP-47and Ses-0265 were selected for adaptive trial.

Crop management

Performance of sesame varieties in high barind tract

The field trial was carried out at the farmer’s field of FSRD site, Kadamshahar, Godagari, Rajshahi during Kharif-1 season 2015 to select suitable variety through on-farm verification of sesame varieties in High Barind Tract. Four varieties of sesame viz. BARI Til-3, BARI Til-4, Binatil-1 and local were tested in the farmer’s field. The experiment was conducted in randomized complete block design with three replications. The unit plot size was 3 m x 2.5 m. Line to line distances 30 cm with continues sowing. Treatment combinations were randomly assigned in each replication. Sesame seeds were sown in 20 March, 2015. Among the tested varieties BARI Til-4 gave the maximum seed yield (1.25 t ha^{-1}) followed by Bina Til-1 (1.18 t ha^{-1}) and BARI Til-3(1.17 t ha^{-1}). Local variety gave minimum seed yield (0.88 t ha^{-1}).

Pest Management

Management of stem rot of sesame through fungicides

The experiment was conducted at Regional Agricultural Research Station, Jessore during Kharif-1 season 2015-2016 and BARI Til -3 was used as planting material. The experiment was designed in RCB with 3 replications . Seven fungicides namely; Indofil (Mancozeb), Provax-200 (Carboxin + Thiram), Bavistin (Carbendazim), Contaf (Hexaconazole), Score (Difenoconazole), Tilt 250 EC (Propiconazole) and Secure (Fenamidione + Mancozeb) were sprayed three times. A control treatment was maintained for comparison. Three sprays were done at 10 days interval starting from first appearance of the symptom of the disease. All the fungicides significantly reduced the percentage of plant mortality. Disease reduction over control ranged from 34.0.-55.46%. The highest yield (1426) kg/ha was recorded from Contaf sprayed plot followed by Score, Secure and Tilt 250 EC sprayed plot. The lowest yield (1057) kg/ha was obtained from control plot. The highest net profit of Tk. 8360 was obtained from the Contaf sprayed plot followed by Tilt 250 EC and Bavistin sprayed plot. Considering benefit cost ratio the fungicide contaf was found to be economic (2.30) followed by Tilt 250 EC (1.95) and Bavistin (1.42).

Soybean (*Glycine max* L)

Varietal Development

Collection of soybean germplasm

A total of five accession of soybean were collected in 2015-16. Four accessions received from Jessore Science and Technology University collected from Japan and one from Australia evaluated during rabi season 15-16 at Gazipur growing in a non replicated trial for future use in the breeding program. The sowing date was 19 November 2015. Seeds were sown in two rows of 4 m long plot with the spacing line to line 30cm and plant to plant 5 cm. One accession which was collected from Australia grown in pot on 16 May 2016 which is in vegetative growth stage. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth.

The ranges for days to flowering, plant height, number of pods per plant, 100 seed weight, plot yield and days to maturity were 42-47 days, 18-28 cm, 5-11, 15-24 gm, 863-1169 kg/ha and 92-125 days respectively. BARI Soybean 6 required 55 days to flower, plant height was 43 cm and 100 seed weight was 14 gm. The hundred seed weight of Jessroe-III (24 g) was the highest. All the accessions given higher seed yield than BARI Soybean-6 except Jessore-IV. Days to maturity of Jessore I & II almost 2 weeks earlier than the BARI Soyabean-6. All the collected accessions were dwarf compare to the released variety BARI Soybean-6. Considering the yield and yield contributing characters plant height and 100 seed weight these 4 genotypes were selected for inclusion in observation trial in the next year.

Maintenance and evaluation of soybean germplasm

A total of one hundred eight genotypes were grown in a non replicated trial at Gazipur to evaluate the materials for future use in the breeding program. The sowing date was 19 November 2015. Seeds were sown in two rows of 4 m long plot with the spacing line to line 30cm and plant to plant 5 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth.

The ranges for days to flowering, plant height, number of pods per plant, 100 seed weight, seed yield per plant and days to maturity were 42-73 days, 17.8-135.2 cm, 0.8-111.8, 2-28 g, 32.87-1987.5 kg/ha and 86-143 days respectively. The per cent highest coefficient of variation (CV%) was recorded for the character pods/plant (86.08) followed by yield per plant (61.02) respectively. Minimum variation was observed in the character days to flowering and maturity. The character 100 seed weight and plant height showed moderate variation. Considering the plant height, pods/plant and 100 seed weight 4 genotypes have been selected for growing in observation trial in the next year.

Observation trial of soybean

Twenty one entries including one check varieties namely BARI Soybean-6 were evaluated in a RCB design with two replications for seed yield and it's components at Gazipur during rabi 2015-16. The unit plot size was 2 rows of 4 m long and the spacing was maintained 40 cm between rows and 5 cm between plants. The sowing date was 19 November 2015. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS respectively, from Urea, TSP, MP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as and when necessary. Data on days to maturity and seed yield per plot were taken on the plot basis. The other yield contributing characters such as plant height, branches/plant and 100 seed weight (SW) were recorded from 5 randomly selected plants of each plot. Recorded data were analyzed statistically.

Statistically significant difference was observed among the genotypes included in the trial for all the characters studied. The entries USDA 4, USDA 11, USDA 60 and USDA 76 required minimum days to maturity (93-95 days) while the entries C-8633411, GC-83001-16, USDA 44, USDA 72, BS-29 took maximum days to maturity (112-116days). The most dwarf entries were USDA- 4 (21cm) and USDA 60 (22cm) which were statistically similar. Maximum plant height was recorded in USDA 85 (52cm) followed by USDA 44 (50cm) and USDA 72 (50cm) while in check variety BARI Soybean-6 (43 cm). The entry LG-92P1825 produced the highest pods (29) per plant followed by USDA 107 (27) and GMOT-13 (26). All the entries produced the higher seed yield compared to the check variety BARI Soybean-6 except the entry MACS-BR-18. The entry GMOT 13 produced the highest seed yield of 1865 kg/ha which was almost double than the check variety BARI Soybean-6. The entry USDA 93 also produced 90% higher yield than the check variety BARI Soybean-6.

Regional yield trial of soybean

Nine entries including two check varieties viz. BARI Soybean-5 and BARI Soybean-6 were evaluated in a RCBD design with three replications for seed yield and it’s component at Gazipur and Hatazari during rabi 2015-16. The unit plot size was 6 rows of 4 m long and the spacing was maintained 40 cm × 10cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from urea, TSP, MP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as when necessary. The yield contributing characters were recorded from 5 randomly selected plants of each plot. Seed yield was converted into kg/ha. Recorded data were analyzed statistically.

Significant difference was observed for yield and yield contributing characters at Gazipur during 2015-16. The genotype Givency was the most dwarf (14 cm) while GMOT-17 was the tallest (74cm) in plant height. Maximum no. of pods per plant (27) was found in the entry GMOT-17 while minimum number in Givency (14). Hundred seed weight of Givency, AGS-95 and BARI Soybean 6 recorded 15g were the maximum statistically different from the remaining entries. Three entries GMOT-17, AGS-79 and KUSH 2004 produced higher seed yield than both the check varieties. The highest seed yield was obtained by the entry GMOT-17 (2028 kg/ha) followed by AGS-79 (1502 kg/ha) and KUSH-2004 (1452 kg/ha) which were 99%, 47% and 42% higher than the check variety BARI

Soybean 6. The genotype GMOT-17 took the maximum days to mature (119 days) followed by AGS-79 (116 days) while the check variety BARI Soybean 5 took 115 days to mature. The three genotypes, Santarose and Givency took 94-97 days to mature.

Average seed yield of two locations, Gazipur and Hatazari reveals that the genotypes GMOT-17 produced the highest seed yield of 2376 kg/ha which was 26% higher than the check variety BARI Soybean 6. The two other genotypes KUSH 2004 and AGS 79 also produced 5% and 2% higher seed yield than the check variety BARI Soybean 6.

Crop management

Screening of soybean genotypes under drought condition

The experiment was conducted in pot under semi controlled condition at net house of Oilseed Research Centre of BARI, Gazipur, Gazipur during 2015-16. The field capacity of the soil was determined earlier. Required amount of water was added to bring the moisture at desired levels as per treatment. The pots were placed on wooden cots inside a rear house. The rear house had a roof of movable polythene paper which was used to cover as and when necessary to protect the pots from occasional rainfall. Thirty genotypes of soybean were evaluated against drought. Drought treatment was imposed by restricting irrigation and plants were re-irrigated when they showed signs of wilting or leaf rolling. Artificially drought were controlled upto maturity. After germination, plants were counted and excess plants were removed to maintain five plants in each pot. Data were collected on days to flowering, days to maturity, plant height, mature pod, seed per pod, 100 seed weight, seed yield per plant, TDW per plant, relative yield/yield stability (RY/YS), dry matter stress index (DMSI) and stress tolerant index STI).

Under drought stress condition genotype LG-92P1825 produced the maximum yield (4.60g/plant) followed BARI Soybean-6 with yield (4.03g). The genotypes BARI Soybean-5, Sohag, BARI Soybean-6, GMOT-13, JS-335, USDA-56, BR-33, USDA-33, USDA-41, SJ-1and LG-92P1825 gave more than 50% DMSI and YS. But the genotypes BARI Soybean-5, BARI Soybean-6, BR-33 and LG-92P1825 gave more than 0.8% STI. So, the genotypes BARI Soybean-5, BARI Soybean-6, BR-33 and LG-92P1825 were selected under drought stress condition on the basis of drymatter stress index and yield stability (>50%) and stress tolerant index (>0.8).

Performance of selected genotypes of soybean under salinity in pot culture

The experiment was conducted during the period from December 2015 to February 2016 at net house of Oilseed Research Centre, BARI, Gazipur. Nine selected soybean genotypes (Assets-95, LG 29P-1141, Gc-84051-G1, Gc-83005, F-83-11347, MTD-16, KHAN-3, Joyawaza and , MTD-451) screened in laboratory under Hoagland nutrient solution culture were used at control,4,6, and 8 dS/m of NaCl solution. Seeds of each genotype were sown in each pot on 14 December 2015. The study was carried out in completely randomized design under factorial arrangement with three replications. Two weeks after sowing, salt solutions were applied in treated pot. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 4, 6 and 8dS/m solution. The root and shoot sample were collected prior to harvest. The collected sample was oven dried at 80^0 C for 72 hours. For root sampling, plastic pots were soaked in water, soil was washed with water and the roots were recovered by passing the soil water suspension through a 2 mm mesh sieve. The yield and yield component data were collected from five randomly selected plants from each treatment at harvest.

Genotypes were greatly influenced by salinity with respect to root dry weight, shoot dry weight, days to flowering, days to maturity and yield over control. Among the nine genotype, F-83-11347, Gc-83005, MTD-16, KANH-3, BARI Soybean-5, BARI Soybean-6 showed more salt tolerance at all the salinity levels in respect of root-shoot growth and yield performance.

Pest management

Screening of soybean genotypes against soybean yellow mosaic virus

The experiment was conducted at Oilseed Research Centre, BARI, Gazipur during rabi 2015-2016 cropping season. Twenty (20) soybean entries were evaluated under natural condition against soybean yellow mosaic virus disease using infector row method. The experiment was conducted in RCBD following 3 replication in continuous row method. Seeds were sown on 18 December 2016. A susceptible variety Shohag was used in the experiment as infector. Every test lines were sown in two rows of 2 m long separated by single row of susceptible infector (Shohag). *Foliar disease was recorded at the pod development stage using 0-8 scale. Among the 20 test lines;* Only one line (AGS 205) showed highly Resistant reaction and six lines (BS-29, COLOMBUS, USDA-93, USDA-47, GMOT-13, TAS-4) were found moderately resistant to the disease. These lines will be further evaluated in the next season.

Evaluation of soybean entries against major insect pest

Twenty (20) entries of soybean were evaluated against leaf roller (*Lamprosema indicata*), hairy caterpillar (*Spilarctia obliqua*) pod borer (*Helicoverpa armigera*), and common cut worm (*Spodoptera litura*) infestation during 2015-16 at ORC, BARI, Gazipur. Design was RCBD with three replications. Of these, three entries namely, Colombus, GMOT -13 and AGS-205 were attacked by less no. of leaf roller (3.43-5.64%), hairy caterpillar (3.00-8.15%), common cutworm (3.15-4.32%) and pod borer (0-1%) than the other entries and check variety BARI Soybean-6.

Sunflower (*Hellianthus annus* L.)

Varietal Development

Maintenance and evaluation of sunflower germplasm

Seventeen accessions of sunflower and BARI Surjamukhi-2 (check) were sown at the research field of ORC, BARI Gazipur on 11 November 2015. Seeds were sown in 2 rows x 3 m long plot, maintaining row to row distance 50 cm and plant to plant distance 25 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Pollen of each entry within a plot was collected and bulked. Then crossing was done within the genotypes of that plot. After crossing, bagging was done properly. Other intercultural operations were done when necessary to obtain optimum plant growth. BARI Shurjomukhi-2 and GP04015 took minimum days to mature (108 days). The minimum plant height was recorded in GP04038 (2) followed by GP04012 and GP04015. The highest seeds/head and highest seed weight/head was recorded in GP-04026.

Development of dwarf inbred lines in sunflower

i) Advancing S_1 to S_2 generations

One hundred and sixty two S_1 single plants of eleven sunflower genotypes were grown at Gazipur. Seeds were sown on 11 November 2015 in ORC research field. Seeds were sown in 6 rows of 3 m long plot where the spacing was 50 cm between the rows and plant to plant 25 cm. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Individual plants were selected for selfing and bagged properly for escaping prevention of out crossing. Pollen were collected and roughed within the same head by hand brush during selfing. Data was recorded on average plant height (cm), head diameter (cm), seeds/head and seed weight/head (g). A total of 162 heads of eleven sunflower genotypes were selfed. The average plant height, head diameter, seeds/head and seed weight/head was recorded. The plants having height close to 100 cm along with head diameter close to 20 cm had been selected to advance generation as S_3. A total of fifty three single plants were selected and will be evaluated as S_3 generations next year.

ii) Advancing S_5 to S_6 generations

One hundred and twenty S_5 single plants of ten sunflower genotypes were grown at Gazipur. Seeds were sown on 11 November 2015 in ORC research field. Seeds were sown in 2 rows of 4 m long plot where the spacing was 50 cm between the rows and plant to plant 25 cm. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Individual plants were selected for selfing and bagging. Pollen were collected and roughed within the same head by hand during selfing. Data was recorded on average plant height (cm), head diameter (cm), numbers of seeds/head and seed weight/head (g). A total of 120 heads of ten sunflower genotypes were selfed. The average plant height, head diameter, seeds/head and seed weight/head was recorded. The plants having height close to 100 cm were selected to advance generation as S_6. A total of forty four single plants were selected out of 120 selfed plants from 10 sunflower genotypes. These selfed single plants will be evaluated as S_7 next year.

Regional yield trial of sunflower

Nine sunflower lines along with check variety BARI Surjamukhi-2 were evaluated for yield and yield contributing traits at Gazipur, Ishurdi, Jessore and Rahmatpur during the Rabi season of 2015-16. Seeds were sown at these locations on 11, 06, 22 and 17 November 2015, respectively. Experiments were laid out in RCB design with 3 replications. Unit plot size was 10 m^2. Each plot consisted of 4 rows which were 4 m long with 50 cm row to row and 25 cm plant to plant spacing. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and the other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Data on days to flowering, days to maturity and seed yield were taken on plot basis. The other yield contributing characters were recorded from 10 randomly selected plants of each plot. Seed yield was converted into yield/ha. Data on plant height and seed yield of the four regions were analyzed combinedly. Recorded data were analyzed statistically by using SAS 9.1 software.

Significant differences among the genotypes were observed for all the yield contributing characters except days to maturity at Gazipur location. The most dwarf genotype was SVS-00901 and BARI Surjamukhi-2 (129 cm) followed by BHAC-01025 (134 cm). The highest head diameter was recorded for BARI Surjamukhi-2 (21 cm). BHAC-04015 produced the highest number of seeds/head (681) followed by SVS-00901 (645). On the other hand, maximum thousand seed weight was obtained from BARI Surjamukhi-2 (53 g) followed by BHAC-04026 (51 g).The entries BHAC-04017, BHAC-04012 and BHAC-01045 at Gazipur, BHAC-04015 and BHAC-01045 at Ishurdi had given higher yield than check variety BARI Surjamukhi-2.

Identification of parental lines for development of hybrid variety in sunflower

Seeds of Hysun-33 were collected from BRAC and selfed to develop S_1 and S_2 in the last two years. S_2 seeds were sown on 12 November 2015 in ORC research field in two rows of 4 m long with the spacing of 50cm between the rows and plant to plant 25 cm. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Individual plants were selected for selfing and bagging. The flower head was protected with suitable cover before the commencement of anthesis in any florets and the cover was retained till fertilization is over in all florets. Artificial self pollination was done with pollen collected from the same flower using a soft brush to enhance seed settings. Data were recorded on the average number of plants selfed, head diameter (cm), numbers of seeds/head and seed weight/head (g). After selfing, considering different parameters 67 plants were selected from Hysun-33. Seeds of these plants would be grown as plant to row method next year.

Adaptive trial of hybrid sunflower (*Helianthus anus*)

Three imported hybrid sunflower varieties and BARI sunflower-2 as a check variety were evaluated under adaptive trial at Gazipur and Rahmatpur locations during 2015-16. The experiment was laid out in randomized complete block (RCB) design with three replications. Unit plot size was 12 sqm (6 rows 4 m long) with the spacing of 50 cm between rows and 30 cm between plants. The seed was sown at Gazipur and Rahmatpur on 11 and 16 November 2015, respectively. Recommended doses of fertilizers were applied @ of 90, 35, 80, 30, 3.6, 1 kg/ha of NPKSZn and Boron from Urea, TSP, MP, Gypsum, Zink Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise good crop. Data were taken on days to flowering, days to maturity, plant height (cm), seeds/head, thousand seed weight and yield/plot. Seed yield was converted into yield/ha. Data on plant height and seed yield of the two regions were analyzed combinedly. Recorded data were analyzed statistically by using SAS 9.1 software.

All the varieties produced higher seed yield compare to check variety BARI Surjamukhi-2 at Rahmatpur, but at Gazipur it was found that only the variety CN-003 produced higher yield than that of the check variety. All hybrid varieties took longer time to mature than the check variety at Gazipur. Except CN-003 the other hybrid varieties were found to be dwarf than that of the check variety at Gazipur.

Crop management

Performance of sunflower varieties under different management practices

The experiment was conducted at the Research field of Oilseed Research Centre, BARI, Gazipur and Benerpota, Satkhira during the rabi season of 2015-2016 to select suitable genotype and management practice for higher yield of sunflower. There were two genotypes (BARI Surjomukhi-2 and SVS 00901) and three management combinations viz. M_1 = Low management (I_0 = No irrigation, W_0= No weeding cum+ thinning, F_0= No fertilizer), M_2 = Medium management (I_1= One Irrigation at 30 DAE, W_1= One weeding cum thinning at 30 DAE, F_1= 43:12:20:15 kg/ha of NPKS respectively) and M_3 = High management (I_2= Two irrigation at 30 and 60 DAE, W_2= Two weeding cum thinning at 30 and 60 DAE, F_2= 86: 24: 40: 30: 3:1: 0.8 kg/ha of NPKSMgZnB respectively). The experiment was laid out in RCBD factorial with three replications. Seed were sown in 8 November 2015 at research field, ORC with a row to row distance of 50 cm and plant to plant 25 cm. Unit plot size was 3m X 4m. Data on yield and yield contributing character were recorded and analyzed statistically using Cropstat program.

Highest seed yield (2.38 t/ha) was recorded from BARI Surjomukhi -2 under M_2 management practice with higher BCR (2.14)at Gazipur and 2.11t/ha was obtaind from SVS 00901 line under M_3 management practice with higher BCR (1.83).

Pest Management

Evaluation of some fungicides and botanicals against leaf blight of sunflower

An experiment was conducted on evaluation of some fungicides and botanicals against alternaria blight or leaf blight of sunflower in the field of Oilseed Research Centre, BARI, Gazipur during 2015-2016 cropping season. Seeds of BARI Sunflower-2 were sown on 25 November 2015 .The experiment was designed in RCB with 3 replications where plot size was 3m x 4m. Irrigation and other intercultural practices were done as and when necessary. The spacing was 50 cm x 30 cm. Eight treatments were included in this experiments. The treatments were: T_1 = Rovral (2g/L), T_2 = Indofil(2g/L), T_3 = Dithane M-45(2g/L),T_4 = Mahogini leaf extract(MLE 10ml/L) T_5 = Mahogini Seed extract(MSE 10ml/L) T_6 = Neem leaf extract (NLE)10ml/L $T_{7=}$ Garlic (*Allium sativum* bulb) extract 10ml/L and T_8 = Control. These botanicals first thoroughly washed with sterilized distilled water then extract was prepared by blending leaves or seeds with water at the ratio of 1:3(w/v). The crop was allowed to grow under natural infection. Three sprays were done on January 08, 18 and 01 February, 2016. In each plot 10 plants were randomly selected and tagged for data recording. Disease data was recorded three times. Final disease data were recorded before 15 days of harvest. Percent Disease Incidence (PDI), head diameter, No. of seed//head, 100 seed weight (gm) and yield (kg/ha) were recorded. Alternaria blight of sunflower scored according to 0-5 scale developed by Meah (1994). The scale was 0= leaves free from leaf spot, 1= 0.1-6% leaf or pod area diseased, 2= 6.1-12% leaf or pod area diseased, 3= 12.1-25% leaf or pod area diseased, 4= 25.1-50% leaf or pod area diseased and 5= above 50% leaf or pod area diseased

Three fungicides (Rovral, Indofil, Dithen m-45) and four botanicals (Mahogini leaf extract, Mahogini seed extract, Neem leaf extract, *Allium sativum* bulb extract) were tested against the disease. The highest disease reduction (62.72%) was obtained from Rovral treated plot followed by Indofil (39.25%) and Allium Sativum bulb extract (33.06%) treated plot. The highest yield 3.2 t/ha was also found in Rovral treated plot followed by Indofil (3.1t/ha) and *Allium sativum* bulb extract (2.9 t/ha) treated plot. From the result it may be concluded that Rovral and Indofil are best fungicides in controlling disease incidence and increasing yield of sunflower over control. Mahogini Seed extract (MSE) followed by *Allium sativum* bulb extract performed better than other botanicals in reducing the disease incidence and increasing the seed yield of sunflower.

Linseed

Varietal Development

Maintenance of linseed germplasm

The experiment was carried at research field of ORC, Gazipur during rabi 2015-16 with twenty genotypes of Linseed including the released variety Neela. Seeds were sown on November 12, 2015. The unit plot size of each genotype/line was 4 m long with 4 rows maintaining 40 cm and 10 cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Collected seed conserved properly. The seed will be rejuvenate in the next year.

Niger

Varietal Development

Maintenance of niger germplasm

The experiment was carried at research field of ORC, Gazipur during rabi 2015-16 with twenty genotypes of Niger including the released variety Shova. Seeds were sown on November 12, 2015. The unit plot size of each genotype/line was 4 m long with 4 rows maintaining 40 cm and 10 cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Collected seed conserved properly. These seed will be rejuvenated the next year

Safflower

Varietal Development

Maintenance of safflower germplasm

The trial was carried out at Gazipur during rabi 2015-16 with 3 variable genotypes of safflower including the check line namely Saff-1. Seeds were sown on November 12, 2015. Each genotype/line was grown in a 4 m long with 4 rows maintaining 40 cm and 10 cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Collected seed conserved properly. These seed will be rejuvenated the next year.

Evaluation of safflower lines (SAARC)

The trial was carried out at Gazipur during rabi 2015-16 with 3 genotypes of safflower collecting from SAARC including the check variety Saff-1. Seeds were sown on November 12, 2015. Each genotype/line was grown in a 4 m long with 4 rows maintaining 40 cm and 10 cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Significant differences among the genotypes were observed for most of the characters studied. Significantly higher seed yield was produced by the line SAF-502. Further evaluation for these lines is recommended for the development of a new safflower variety.

Crop management

Four crop-based cropping pattern studies for increasing cropping intensity and productivity

Field experiments were conducted at the Bangladesh Agricultural Research Institute, Gazipur during 2015-2016 (July 2015 through June 2016) to study the comparative agronomic performance and economic return of four crops based cropping patterns. The cropping patterns were as follows: CP_1 = T. Aman (var. BRRI dhan 57) – Mustard (var. BARI Sarisha-16) – Mungbean (var. BARI Mung-6) – T. Aus (var. BRRI dhan-48), CP_2 = T. Aman (var. BRRI dhan 57) – Garden pea (var. BARI Motorsuti-3) – Boro (var. BRRI dhan 28) -T. Aus (var. BRRI dhan 48), CP_3= T. Aman (var. BRRI dhan62) –Lentil(var. BARI mosure-3) –Sesame (var. BARI Til-4) – Kankong (var. BARI gimakolmi-

1), CP_4 = T. Aman (var. Binadhan 7) – G.nut (var. BARIChinabadam-8) + garlic (var. BARIRashun-1) – T. Aus (var. BRRI dhan 48),CP_5= T. Aman (var. BRRI dhan 62) – G.nut (var. BARI Chinabadam-8)+ onion (var. local) –T. Aus (var. BRRI dhan 48)and CP_6 = T. aman (var. Binadhan 7) – Fallow – Boro (var. BRRI dhan 28) – Fallow (Control).Five cropping patterns (CP_1, CP_2 CP_3, CP_4 and CP_5) are composed with four crops; and one cropping pattern is composed with two rice crops as control to compare with the other five cropping patterns. The experiment was laid out in a Randomized Complete Block (RCB) design with 4 replications. Data on yield and yield contributing characters were recorded for all the crops.

The results showed that four crops may be grown successfully one after another in sequence in all the five cropping patterns.The highest rice equivalent yield (REY) 27.55 t/ha was obtained from the cropping pattern CP_5 (T. aman rice – Groundnut +onion – T.aus rice) in 2015-16 and it was followed by CP_2 (T. Aman – Garden pea – Boro -T. Aus) (24.90t/ha). The highest gross margin (Tk. 301148/-/ha) and BCR (3.69) were obtained from CP_5 (T. aman rice – Groundnut +onion – T.aus rice) and it was followed by CP_2 (3.19) (T. Aman – Garden pea – Boro-T. Aus)and CP_3 (3.0)(T. Aman – Lentil – Sesame-Kangkong) . So these four crops based cropping patterns will help for increasing cropping intensity, crop productivity and at the same time more employment opportunity will be created for male and female agricultural workers.

Post harvest and biochemical studies

Determination of tocopherol content in vegetable oils using HPLC fluorescence detection method

The present study was conducted in Central Laboratory, Oilseed Research Center, BARI, Gazipur during the period from December 2015 to April 2016. Mustard oil, soybean oil and rice bran oil were collected from the local market. Tocopherol determination levels in foods were great importance to adjust the ingestion of nutrients by the population. Tocopherol mixed standard was obtained from Sigma, USA and was prepared in iso-propanol and stored at -20ºC in dark bottle for up to a month. An HPLC system (Dionex), consisting of automatic sampler, solvent mixing module, on-line degasser, quaternary pump, thermostatted column compartment, control system and a fluorimetric detector was used. The procedure for the determination of tocopherol was taken from literature (Chen and Bergman, 2005).

The results/values expressed mg/100 g for total (alfa-, beta-, and gama) tocopherol were 28.007mg/100g in mustard oil, 22.501 mg/100g in soybean oil, and 10.961 mg/100g in Rice bran oil, respectively. This method can be used to assess the influence of genetic modification of oil seed on the distribution of tocopherols or the effects of tocopherols on the oxidative stability of edible oils.

Chemical characterization, oryzanol and fatty acid profile of rice bran oil in Bangladesh

The experiment was conducted in Central Laboratory, Oilseed Research Center, BARI, Gazipur during the period from August 2015 to April 2016. Rice bran oils brand (ACI RBO, Sorna RBO, Kollani RBO, Pran metro RBO, White gold RBO) were purchased from local market. Fatty acids profile in the oils under study was carried out according to the procedure with some modifications as described by Were *et al.* (2006), and the procedure for the determination of oryzanol was taken from literature (Chen and Bergman, 2005).

The results of this study showed that the major fatty acids were found in different brands of Rice bran oil (RBO) such as palmitic (20-39%), stearic (2-4%), oleic (40-45%), linoleic acid (13-33%) and linolenic acid (0.35-1.45%). Oryzanol content of the RBO extracted from different brands of RBO are 0.24-0.38%. Oryzanol have cholesterol-lowering properties and its beneficial effects viz, gastrointestinal disorders and nerve imbalance. Rice Bran Oil might be better edible oil in Bangladesh.

5 SPICES CROPS

Onion

Varietal Development

Evaluation of onion germplasm

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2015 -2016 to study the performance of onion germplasm. Seven onion germplasm (ON0338, ON0339, ON0340, ON0341, ON0342, ON0343 and ON0344) were used in this study. The experiment was laid out in randomized complete block design with three replications. In previous year (2014-2015) bulb of C3-4 generation was planted for seed production. At that time, seven individual plants were selected based on their morphological characters. At maturity seeds were collected and stored. In this year, the seven onion germplasm were tested for their bulb production. The forty five days old seedlings were planted on 10th January 2016 and harvested on 10 April 2016. It was found that the germplasm ON0338 gave the highest number of leaves per plant (9.04) and the lowest (7.68) was found in ON0343. Significantly the highest bulb diameter and single bulb weight (4.21 cm & 19.96 g, respectively) was found in ON0338 and the lowest (3.69 & 15.14 g, respectively) was recorded from ON0343. The highest bulb yield (13.48 t/ha) was found from ON0338 and the lowest was found from ON0344 (9.15 t/ha).

Evaluation of onion germplasm in winter season

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during November, 2015 to April 2016 to develop superior variety (s) with higher yield. Sixteen (16) different onion germplasm (ONO228, ONO250, ONO252, ONO262, ONO263, ONO268, ONO277, ONO278, ONO279, ONO280, ONO283, ONO284, ONO285, ONO287, ONO295 and ONO296) along with three varieties (BARI PIaz-1, BARI PIaz-4 and BARI PIaz-5) were evaluated based on their yield and other desirable characters. Forty five days old seedling was transplanted on 20th December 2015 and harvested on 12th April, 2016. Among the lines, the highest yield (16.81 t/ha) was obtained from ON0228 and the lowest yield (3.57 t/ha) was obtained from ON0296.

Evaluation and selection of poly-crossed first generation onion

The experiment was conducted at the Regional Spices Research Center, BARI during November, 2015 to April 2016 to evaluate the variability created in onion through poly-crossing method. In the last year, polycross was made among five varieties (BARI Piaz-1.2, 3, 4 & 5) and two germplasm (Indian large and Taherpuri) to develop variability in onion genotypes. In this year, seven poly-cross onion populations were evaluated considering agronomic performances and yield parameters. The 45 days old seedlings of 8 polycross onion genotypes were planted on 30 December, 2015 and harvested on 28 March, 2016 A lot of variations were observed in respect of bulb size, attractiveness, color and shape of bulb compared to their mother bulb characteristics. Larger bulbs were produced from Indian large.

Purification and improvement of Bari Piaz-1 and Bari Piaz-4

The experiment was conducted at Spices Research Sub-Centre, BARI, Faridpur during January to April 2016 to purify and improve BARI Piaz-1 and BARI Piaz-4 with desired characters e.g., colour, size & shape, keeping quality, pungency, disease & insect resistance etc.Two different varieties BARI

Piaz-1 and BARI Piaz-4 were used for this study and from BARI Piaz-1 two different shapes i.e., flat and round and from BARI Piaz-4 three different shapes i.e., globe, broad elliptical and spindle were isolated. The experiment was a non-replicated trial and no design was followed. The seeds obtained from the third generation selfing were sown and bulbs were produced. Seedlings were transplanted on 07 January, 2016 and harvested on 9 April, 2016. From BARI Piaz-1, 90% flat shaped onions were found from flat shape mother bulb and 43% round were observed from round shape mother bulb and this result indicated that flat shape was dominated over round shape bulb. On the other hand, from BARI Piaz-4, 50% globe shaped onions were found from globe shape mother onion bulb. While 46% broad elliptical and 30% spindle were observed from broad elliptical and spindle mother bulb respectively and the rest of bulbs were globe in shape. These results also indicated that globe shape was dominated over broad elliptical and spindle shape in BARI Piaz-4 cultivar. The bulbs with desired characters were selected and stored for further study to make inbreed for future breeding program.

Development of onion thrips tolerant line

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2015-2016 to developing winter onion lines/varieties tolerant against thrips having good yield potential. The C_2 bulbs of ON0332 (glossy type, non-waxy) were used in this study for seed production. Thrips (*Thrips tabaci* Lind.) is one of the most important common insect pests of onion which indirectly or directly reduce the yield of onion bulb and seed also. Normally onion plant is non-glossy type (waxy) which is encouraging the thrips attack. But glossy (non- waxy) type plant showed tolerance to the thrips. Spices Research Centre (SRC) have isolated some plants which were non glossy (waxy) type and advancing it up to C_2 generation. In this year seed production was done from C_2 generation. Bulbs were planted on 25 November 2015 and harvested on 10 April 2016. It was observed that less thrips population (5.68) was recorded on glossy type (non-waxy) plant (ON0332). Yield and yield contributing characters were also studied and found satisfactory. The plant height (70.25 cm), leaf number (9), number of umbel per plant (3), umbel size (6.8 cm), number of flower per umbel (456) and seed yield (525 kg/ha) were recorded. At maturity stage seeds were harvested, processed and stored for bulb production for the following year.

Performance study of two advanced lines of onion

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2015-2016 to study the performance of two advanced onion lines in respect of yield and bulb quality. Two advanced onion lines viz; C_4-3 and C_4-7 including BARI Piaz-1 & 4(as check) were used in the study. The treatments were: V_1=BARI Piaz-1, V_2= BARI Piaz-4, V_3= advanced line C_4-3 and V_4= advanced line C_4-7. Bulbs were planted on 25 November 2015 and harvested on 10 April 2016. In Bangladesh aspect, consumers like brownish and round shape onion. For that reason, the market price of BARI Piaz -1 is always higher than BARI Piaz -4. Keeping this view in mind, random matting was made between the above mentioned varieties in previous years and advancing it up to four generation. It was found that V_3 gave the highest plant height (46.00 cm) and the lowest (39.50 cm) was found from V_1. Significantly the highest bulb length (4.90 cm) was observed from V_2 and the lowest (2.80 cm) was found from V_1. It was found that V_3 gave the highest (4.10 cm) bulb diameter and the lowest (3.01 cm) was recorded from V_1. The highest bulb yield (15.76t/ha) was found from V_3 while the lowest was found from V_1 (10.26 t/ha). Significantly the highest TSS (14.24%) was recorded from V_1 followed by V_3 (12.60%) and V_4 (11.20%) and the lowest (10.60%) was found in V_2. The lowest percentage of disease incidence (2.25) was recorded from V_4 treatment and the highest (4.00) was recorded from V_2 treatment.

Seed production of polycross second generation population of onion

The experiment was conducted at the Regional Spices Research Center, BARI, Gazipur during November, 2015 to April, 2016 for the production of seeds of polycross F_2 population to create stability and selection of better lines from polycross F_2onion population. Bulbs produced from eight onion polycross F_1 population were planted in the field for 8 treatments and allowed to free cross among each other without any control. Bulbs were planted on 09 November, 2015 and harvested at 25 May, 03 and

06 April, 2016. All genotypes had lots of variations in respect to number of umbels per plant, seeds per umbel as well as seed yield per plant. F_2P_1 (Source BARI Piaz -1) gained early flowering (83 DAP) and produced the maximum amount of seeds (440.0 g) while Agrifound red originated from F_2P_6 population produced the minimum number of flower stalk (1.6/bulb) and seeds (210 g).

Evaluation of burmis onion germplasm

Experiments were conducted at the Regional Spices Research Center, BARI, Gazipur during November, 2014 to April 2016 to evaluate the performance of Burmis onion considering agronomic and yield parameters for its bulb and seed production potentiality. Bulbs were planted on 12 December, 2015 and harvested on 22 March, 27 march and 31 March, 2016. Seed production of Burmis onion was done in single plot maintaining isolation distance and covering with fine meshed nylon net during flowering. Burmis onion adopted well in our environment and performed better (both seed and bulb) in last two generations. Both as seed and bulb yield increased in the 2nd year compared to its mother bulb. At the 2nd year, Burmis onion performed better compared to BARI Piaz-1.

Cultural management

Effect of planting method on onion bulb production

The experiment was conducted during *rabi* season of 2014-15 and 2015-16 at spices Research Sub-centre, Faridpur to evaluate the effective planting method for onion production. the experiment was laid out in a randomized complete block design with six replications. There were four treatments viz., Raised bed +SRC practice, Raised bed +Farmer’s practice, Flat method+ SRC practice, Flat method+ Farmer’s practice. BARI Piaz-1 was used as planting material. BARI Piaz-1 used as used as the test crop. In SRC practice seeds were sown at 15 November, 2014 and seedlings were transplanted to raise bed in the main field at 28 December, 2014. In 2015-16 seeds were sown at 10 November, 2015 and seedlings were transplanted to raised bed in the main field at 20 December. In farmer’s practice, seed were sown at 30 November, 2014 and seedlings were transplanted at 18 January, in 2015-16 seed were sown at 28 November, 2015 and seedlings were transplanted at 16 January, 2016. Depending on maturity, in SRC practice the crop was harvested on 04 April, 2015 and 24 March, 2016 respectively. In farmer’s practice crop was harvested on 13 April, 2015 and 02 April, 2016 respectively. The results of the study revealed that planting method and management practices had significant impact on yield and yield attributes of onion. Significantly the highest yield 14.42 t/ha in 2014-15 and 12.57 t/ha in 2015-16 were recorded from Raised bed + SRC recommended practice. The lowest yield 8.05 t/ha in 2014-15 and 7.66 t/ha in 2015-16 was recorded from Flat method + Farmer’s practice.

Nutrient and water management

Effect of varieties and time interval of nitrogen application on summer onion

The experiment was conducted at RSRC, Magura during *kharif* season 2016 to select the suitable variety and optimum time interval of split application of nitrogen for maximizing the yield of summer onion.The experiment was laid out in RCB design with three replications. Three varieties of summer onion viz., BARI Piaz-2 (v_1), BARI Piaz-3 (V_2) and BARI Piaz-5 (V_3) were tested under this trial. Three split applications of urea viz., 10 (T_1), 25 (T_2) and 40 (T_3) days after planting (DAP) were included in the study. The crops were planted on 24 February, 2016 and harvested on 6 May 2016.The highest bulb yield (22.23 t/ha) was recorded from the treatment combination of V_3T_2 (BARI Piaz-5 with N split application at 25 DAP) while the lowest bulb yield (6.77 t/ha) was obtained from treatment combination of V_1T_3 (BARI Piaz-2 with N split application at 40 DAP).

Insect pest and disease management

Development of management tactics against thrips (*Thrips tabaci*) in onion

Several management approaches were evaluated against thrips in onion at RSRC, Gazipur during *rabi* 2015-16. The experiment was laid out in a randomized complete block design with the three replications. The number of treatments were 5 viz. T_1= White sticky trap; T_2= White sticky trap + spraying of Spirotetramet (Movento 150OD) @ 1ml/L of water; T_3= Alternate spraying of Azadirectin (Bio-neem plus 1EC) @ 1ml/L of water and Spirotetramet (Movento 150OD) @ 1ml/L of water; T_4= Alternate spraying of Spinosad (Success 2.5SC) @ 1.2ml/L of water and Spirotetramet (Movento 150OD) @ 1ml/L of water and T_5= Untreated control. BARI Piaz-4 was the test crop. Seedlings were transplanted on 22 December, 2015 maintaining 15cm x 10cm spacing. Treatments were applied four times during the crop growth period at 10 days interval in the field as well as thrips population was assessed right before spraying starting from 42 days after transplanting by using magnifying glass. The reduction of thrips population was maximum (90.33, 91.6, 89.09 and 77.8%) in T_3 treatment followed by T_4 treated plot after 42, 52, 62 and 72 DAT, respectively. These two treatments were statistically similar after all the spray. The highest bulb yield (18.74t/ha) and highest MBCR (11.26) was also obtained from T_4 treatment followed by T_3 treatment.

Evaluation of onion genotypes against thrips and iris yellow spot virus

The field experiment was conducted at SRC, Bogra during *rabi* season of 2015-16 to test the performance of different onion genotypes against thrips and iris yellow spot virus. Eleven different onion genotypes (ONO252, ONO254, ONO263, ONO277, ONO278, ONO280, ONO281, ONO282, ONO284, ONO285 and ONO332) along with BARI Piaz-1, 2, 3, 4 and 5 were evaluated against thrips and iris yellow spot virus. Treatments were assigned to a randomized complete block design with three replications. The seedlings of onion were transplanted on 22 December, 2015. Depending on the maturity, the crop was harvested on 10 April, 2016. Out of eleven genotypes, ONO332 and ONO278 resulted less than 8.50 thrips per plant and lowest iris yellow spot virus (2.40 and 5.47 per plant) with higher bulb yield (13.93 and 12.24 t/ha) were characterized as highly resistant. Genotype ONO254 resulted more than 16.90 thrips per plant and highest iris yellow spot virus (16.60 per plant) with lowest bulb yield (4.28 t/ha) were grouped into highly highly susceptible.

Effect of fungicides in controlling bulb rot of onion

The experiment was conducted in sick plot at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to find out the effective control measure of basal or bulb rot of Onion. The experiment was carried out following Randomized Complete Block Design with three replications. The eight treatments were T_1= Healthy and fresh Bulb, T_2= Bulb treatment and soil drenching with Cabriotop (Pyraclostrobin 5% + Metiram 55% WG) @0.3%, T_3= Bulb treatment and soil drenching with Bavistin DF (Carbendazim) @0.25%, T_4= Bulb treatment and soil drenching with Folicur 430 SC (Tebuconazole) @0.1%, T_5= Bulb treatment and soil drenching with Provax 200 WP (Carboxin + Thiram) @0.25%, T_6= Bulb treatment and soil drenching with Companion (Carbendazim + Mancozeb) @0.2%, T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (Azoxystrobin + Difenoconazole) @0.1% and T_8= Control. Bulb of BARI piaz-4 was used in this experiment. Treated bulbs were planted on November 3, 2015 and harvested from 10-13 April, 2016. The lowest emergence (78.44%) of bulb was recorded in control plots and the highest emergence (96.22%) was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC plot. The lowest bulb rot incidence (9.35%) and highest disease reduction over control (75.85%) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC treated plots which was statistically dissimilar to all other treatments. The highest bulb rot incidence (38.72%) was obtained from untreated control plots which was followed by Healthy and fresh Bulb (36.83%). Significantly higher seed yield (605.55 kg/ha) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC plot which was followed by Bulb treatment and soil drenching with Cabriotop (590.11 kg/ha) plot and Bulb treatment and soil drenching with Provax 200 WP (565.45 kg/ha), but Control treatment gave the lowest seed yield (408.55 kg/ha) which was statistically similar with Healthy and fresh Bulb (432.70 kg/ha) and Bulb treatment and soil drenching with Bavistin DF (438.90 kg/ha) plot.

Garlic

Varietal development

Evaluation of garlic germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during *rabi* season 2015-2016 to select the promising garlic germplasm for releasing a variety. Fourteen different garlic lines (GC001, GC005, GC0012, GC0013, GC0038, GC0027, GC0028, GC0029, GC0030, GC0031, GC0035, GC0036, GC0039 ,GC0040 and BARI Rashun-1 check as) were evaluated based on their yield and other desirable characters. The experiment was laid out in RCB design with three replications. The cloves were planted on 30 October 2015 and harvested on 18 March, 2016. Among the lines, the highest yield (12.30 t/ha) was obtained from GC0038 and the lowest (5.0 t/ha) was found from GC001. Disease severity was also lower in GC0038. All the yield contributing characters were found better from GC0038 line.

Regional yield trial of promising garlic line

The experiment was conducted at Spices Research center, Bogra, Spices Research Sub-center Lalmonirhat, Agricultural Research Station Comilla, Regional Spices Research Center Magura and Spics Research Sub-center Faridpur during November 2015 to March 2016. Four advance lines of garlic (GC0018, GC0024, GC0017, GC0034) and BARI Rashun-1 as check were included in the study. In case of location the highest yield (8.77 t/ha) was recorded in SRC, Bogra and the lowest yield was recorded (6.85 t/ha) in Comilla location. In case of germplasm the highest yield (9.31 t/ha) was found from GC0034 while the lowest (6.55 t/ha) was found from BARI Rashun-1. The combined effect of location × advance line gave significant effect on yield and other parameters. The highest yield (11.19 t/ha) was obtained from GC0034 at SRC, Bogra location, while the lowest yield (5.87 t/ha) was obtained from GC0018 at Comilla location. . Significantly higher plant height, number of leaves/plant, bulb length, bulb width, clove length, clove width, yield /plant and yield (t/ha) was highest from GC0034 with each location. Considering all the characters, two lines (GC0024 and GC0034) were found promising and proposed for variety release.

Cultural management

Effect of planting time and harvesting period on the yield of garlic for Jessore region

The study was conducted at RSRC, Magura during 2015-2016 to find out the optimum planting time and harvesting period for quality garlic production. The two factor experiment was laid out in Randomized Complete Block design with four replications. The treatments comprised two planting time viz., 15 October and 15 November and three harvesting period viz., 130, 140 and 150 days after planting (DAP). The test variety was BARI Rashun-2. The highest yield (9.16 t/ha) was recorded from mid-October planting when harvested at 140 DAP. The lowest yield (2.90 t/ha) was found from mid-November planting when harvested at 150 DAP.

Field performance of power tiller operated bed planter for garlic planting

This study was conducted to evaluate the machine performance for garlic production and to compare the yield performance with that of conventional method. This research was conducted to drop garlic cloves into a soil holes through a inclined plate metering system. A Power tiller driven garlic clove planter has been developed with locally available materials in Spices Research Centre, BARI, Shibganj, Bogra during 2014-15. The garlic clove planter consists of i) Garlic clove hopper; ii) Inclined plate metering device; and iii) Power transmission system. Inclined plate type seed metering device for maize planting was modified for garlic clove planting. Due to garlic clove thickness the clove was dropped from metering device groove during rotation of metering device. Plywood board was used to develop this type of metering device. BARI Rashun-1 was used as the planting material. From field test, the average garlic clove to clove spacing was found 9.85 cm. Detailed performance of the planter and modification will be evaluated in the next season.

Insect pest and disease management

Screening of garlic lines/variety against stemphylium leaf blight disease

The study was conducted at Spices Research Center, Bogra during *rabi* season 2015-2016 to find out the resistance source of garlic against stemphylium blight disease. The experiment was laid out in Randomized Complete Block Design with three replications. A total of fifteen (15) different garlic lines/variety (GC001, GC005, GC0012, GC0013, GC0017, GC0027, GC0028, GC0029, GC0030, GC0031, GC0035, GC0036, GC0038 and GC0040) and a susceptible variety BARI Rashun-1 as check were used in this experiment. Planting was done on 29 October, 2015, maintaining 10 cm x 10 cm. spacing and harvested on 22 March 2016. Among these lines, thirteen lines including BARI Rashun-1 were found to be moderately susceptible and one line (GC0031) showed susceptible to stemphylium blight disease. The highest yield (6.27 t/ha) was obtained from GC0027 and GC0028 while the lowest yield (4.23 t/ha) was obtained from GC005.

Effect of fungicide(s) in controlling stemphylium blight disease of garlic

The experiment was conducted at Spices Research Center, Shibganj, Bogra during November 2015 to March, 2016 to find out the effective fungicide(s) in controlling Stemphylium blight disease of garlic. The experiment was laid out a Randomized Complete Block Design with three replications. BARI Rashun-1 was used for this experiment. Eight fungicides along with control (untreated) were included as treatment in this study. The treatments were T_1= Trizole 75WG (Tebuconazole + Trifroxostrobin) @0.05%, T_2= Amister Top 325 SC (Azoxystrobin + Difenoconazole) @0.1%, T_3= Deconil 500 SC (Chlorthalonil) @0.15%, T_4= Cabriotop(Pyraclostrobin 5% + Metiram 55%) @0.3%, T_5 = Secure 600 WG (Fenamidone + Mancozeb) @0.15%, T_6 = Protect 52.2WP (Iprodione + Carbendazim) @0.2%, T_7= Tared 280 SC (Azoxystrobin +Cyproconazole) @ 0.05%, T_8= Rovral 50WP (Iprodion) @0.2% and T_9= control (no spraying). Planting was done on 08 November, 2015, maintaining 15 cm x 10 cm spacing. Four sprays were applied at an interval of 10 days at 42, 53, 64 and 75 DAP (Days after planting) starting from first appearance of disease symptoms. The crop was harvested on 27 March, 2016. The lowest (19.07) percent disease index (PDI) was recorded in Trizole sprayed plots and the highest (57.21) percent disease index was recorded in control plots. The highest percent disease reduction over control (64.83) was recorded from Trizole sprayed plots and the lowest (39.00%) was recorded in Cabriotop sprayed plot followed by Rovral sprayed plot. The highest yield (8.37 t/ha) was obtained from Trizole sprayed plots and the lowest yield (4.03 t/ha) was recorded in control plots.

Chilli

Varietal development

Study of genetic diversity in char land chilli

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2015-2016 to study the genetic diversity and selection of suitable genotype for future breeding program. Ninety five chilli lines of char land were used in this study. D^2 analysis of 95 chilli lines and analysis of variance were done. The lines were grouped into seven clusters. It was found that the inter-cluster distance was larger than the intra-cluster distance. The highest intra-cluster distance was observed in cluster I(1.0953) and the lowest was in cluster III (0.533).The highest inter-cluster distance was observed between clusters V and I (16.752), followed by cluster II and I (14.571), III and I (12.767), VII and V (11.305). The lowest inter-cluster distance was observed between cluster III and II (2.516) followed by V and II (2.577). It may be concluded that the cluster V and I could be used for future breeding work.

Maintenance breeding of chilli

Chill is a self-pollinated crop but 2-90% out crossing is occurred by different insect pollinators, not by rain/wind. Due to out crossing the varietal purity of chillies are decreased day after day. To maintain the varietal purity, the experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2015-2016 with a view to maintaining the varietal purity through maintenance breeding. Three chilli varieties (BARI Morich-1, 2 and 3) were used in this study. In each variety, desired plants were selected according to the morphological characters of the mother parent. Red ripe fruits were collected from the specific characterized plants for maintaining varietal purity. After ripening seeds were collected, processed and stored for future study.

Cultural management

Effect of stages of harvest and post-harvest ripening period on seed quality in naga chilli

The experiment was conducted at Regional Spices Research Center, Gazipur during April to September, 2014 and August, 2015 to February, 2016 to find out suitable harvest stage and post-harvest ripening period for securing good quality seeds in naga chilli. The experimental crop was raised with naga chilli involving three stages of fruit harvesting viz., breaker (S_1), red ripe(S_2) and wrinkle (S_3) stage and four levels of post harvesting ripening period viz., 0 (PHR_1), 3 (PHR_2) ,6 (PHR_3) and 9(PHR_4) days after harvesting . Seedlings of 35-40 days ages were planted on September, 2015 maintaining 60cm × 25cm spacing. The crop was started to harvest according to treatment from November and completed on February, 2016. Seeds from the fruits were extracted manually and placed on blotting papers in Petridis. Fruits harvested from red ripe and wrinkle stages showed maximum germination percentage 97.38 (in 2014) and 92.63(in 2015-2016), respectively. Maximum germination index (3.24 in 2014 and 3.28 in 2015-16) was recorded from wrinkle stage in 2014 and 2015-2016.Seeds extracted at 0 day post harvesting ripening period provided longest root (5.66 cm in 2014, 5.20 cm in 2015-16), shoot (3.03 cm,3.08cm) and maximum vigor index (590.28,745.24) with G.I. (2.19,2.23) in both the studies period. Seeds obtained immediately after harvested fruits (0 day) gave maximum germination percentage (99.04) at red ripe stage in 2014 while seeds from both wrinkle and red ripe fruit tested at 0 and 3 post harvesting ripening period exhibited maximum germination percentage (99.33,97.50 and 96.5,93.93, respectively). Besides, seeds extracted from the fruits harvested at red ripe stage with 0(zero) days of post harvesting ripening period showed maximum vigour index (821.90) in 2014 , on the other hand, seeds extracted from the fruits harvested at wrinkle and red ripe stage allowed 0 days post-harvest ripening period recorded maximum vigour index (793.5 and 787.91), respectively during 2015-2016.

Insect pest and disease management

Development of management approach against thrips-mite complex of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to develop an integrated management approach against thrips-mite complex of chilli. The number of treatments were 6 viz. T_1= White sticky trap @ 40 trap/ha; T_2= Spraying of Chlorphenapyr (Intrepid 10SC) @ 1ml/l; T_3= White sticky trap + Chlorphenapyr (Intrepid 10SC) @ 1ml/l; T_4= White sticky trap + Abamectin (Vertimec 1.8EC) @ 1.2 ml/l + Spinosad (Success 2.5SC) @ 1.2 ml/l; T_5= White sticky trap + Bioneem plus (Azadirachtin 1EC) @ 1ml/l + Abamectin (Vertimec 1.8EC) @ 1.2 ml/l and T_6= Untreated control. Treatments were assigned in a randomized complete block design with three replications. BARI Morich-3 was used as test crop for this trial. The seedlings were transplanted on 02 November, 2014. Depending on the maturity, the red ripe chilli harvesting was started from March, 2015 and completed on 10 May, 2015. Spraying of Abamectin (Vertimec 1.8EC) and Spinosad (Success 2.5SC) @ 1.2ml/litre of water + White sticky trap @ 40 traps/ha resulted the lowest thrips (0.86 thrips/leaf) and mite (0.97 mite/leaf) population with highest marginal benefit cost ratio of 11.92. The highest percentage of thrips (87.02%) and mite (87.32%) population reduction over control with maximum red ripe chilli yield (14.70 t/ha) was also obtained from White sticky trap + Abamectin + Spinosad. Thrips and mite populations were negatively correlated with Chlorophyll Concentration Index of leaf. However, the lowest percentage of upward (19.05%) and downward leaf curl (21.08%) was also obtained from White sticky trap + Abamectin + Spinosad treated plot followed by White sticky trap + Azadirachtin + Abamectin (22.75% and 25.15%, respectively) while the highest percentage of upward (71.25%) and downward leaf curl (82.38%) was obtained from untreated control. So, installation of sticky white trap along with spraying of Abamectin and Spinosad may be recommended for effective management of thrips-mite complex in chilli.

Role of intercrops for the management of chilli pests

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to know the effect of different intercrops for the management of chilli pests. The number of treatments were 6 viz. T_1= Chilli + Carrot; T_2= Chilli + Tomato; T_3= Chilli + Groundnut; T_4 = Chilli + Coriander; T_5 = Chilli + Garlic and T_6= Sole chilli. Treatments were assigned in a randomized complete block design with three replications. BARI Morich-3 was used as test crop for this trial whereas unknown cultivar of carrot, BARI Tomato-9, BARI Chinabadam-8 and BARI Dhonia-1 were used as intercrop for this trial. The seedlings were transplanted on 20 October, 2015. On each plot where intercropping was done, one row of chilli was alternated with two rows of intercrops. Depending on the maturity, the red ripe chilli was harvesting from February, 2016 and completed on 25 April, 2016. Among the different intercrops tested, chilli intercropped with garlic and carrot performed well by recording lowest population of sucking pests, leaf curl index, larval population of *Helicoverpa armigera* and *Spodoptera litura* with fruit damage. Whereas, the highest pest population of aphids, thrips, mite, leaf curl index, larval population of *H. armigera* and *S. litura* with fruit damage was observed in sole chilli crop. Mean yield data revealed that, the treatment chilli intercropped with garlic recorded highest red ripe chilli yield of 11.70 t/ha and it was statistically similar to treatment, chilli + carrot (11.30 t/ha) and chilli + coriander (9.57 t/ha) whereas, intercrop yield was highest in chilli + tomato (22.80 t/ha) followed by chilli + carrot (12.05 t/ha) and chilli + garlic (7.30 t/ha). Among the different intercrops, the highest marginal benefit-cost ratio (22.73) was recorded from chilli + garlic, followed by chilli +coriander (21.89), chilli + carrot (21.15) and chilli + tomato (20.71) whereas chilli +groundnut intercrop recorded the lowest marginal benefit-cost ratio (9.47). Predators like coccinellids were found greatly distributed in the crop having different intercrops. Chilli intercropped with garlic and coriander supported good activity of the predators. It appeared that growing intercrops in between the main crop was found advantageous in the management of chilli pest's complex besides yield benefits.

Role of border crop for the management of thrips-mite complex of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to find out the effect of border crop for the management of thrips-mite complex and the activity of natural enemy of chilli. The number of treatments were5 viz. T_1= Chilli with two row of maize all along the border; T_2= Chilli with two row of maize all along the border + Two spraying of Bioneem plus (Azadirachtin 1EC) @ 1ml/l at 7WAT and 9WAT; T_3= Chilli with two row of maize all along the border + Spraying of Bioneem plus (Azadirachtin 1EC) @ 1ml/l at 7WAT followed by Difenthiuron (Polo 500SC) @ 1ml/l at 9WAT; T_4= Recommended plant protection measure (RPP)-Spraying of Dimethoate (Tafgor 40 EC) @ 1ml/l at 5WAT and 7WAT, Propargite (Omite 57 EC) @1ml/L at 9WAT and Carbaryl (Sevin 50WP) @2g/l at 11DAT and T_5= Untreated control. Treatments were assigned in a randomized complete block design with three replications. BARI Morich-3 was used as test crop for this trial. The seedlings were transplanted on 20 October, 2015. Before transplanting chilli seedlings, seeds of maize hybrid (ACI 501)) were sown in two rows all along the border of each treatment fifteen days earlier to chilli planting and later thirty five days old chilli seedlings were transplanted to main field. Depending on the maturity, the red ripe chilli was harvesting from February, 2016 and completed on 25 April, 2016. Among different treatments, it was found that chilli crop bordered by two rows of maize with two interventions of spray (first spray with Bioneem plus @ 1 ml per litre at 7 WAT and second spray with Difenthiuron @ 1 ml per litre at 9 WAT) recorded higher yield (11.90 t/ha) with least leaf curl damage due to thrips (0.77 LCI/plant) and mites (0.28 LCI/plant) at 13 WAT and found significantly superior to all other treatments and standard check. So, chilli crop bordered by two rows of maize with two interventions of spray (first spray with Bioneem plus @ 1 ml per litre at 7 WAT and second spray with Difenthiuron @ 1 ml per litre at 9 WAT) may be recommended for effective management of thrips-mite complex in chilli.

Effect of mulching materials against chilli pests

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to study the effect of different mulching materials against chilli pests. The treatments were T_1= Chilli mulched with transparent polythene; T_2= Chilli mulched with dry banana leaf @ 2 t ha^{-1}; T_3= Chilli mulched with black polythene; T_4 = Chilli mulched with rice straw @ 2 t ha^{-1}; T_5 = Karate 2.5EC (Lamda cyhalothrin) @1ml/l (Standard check) and T_6= Untreated control. Treatments were assigned in a randomized complete block design with three replications. BARI Morich-3 was used as test crop for this trial. The seedlings were transplanted on 25 October, 2015. Depending on the maturity, the red ripe chilli was harvested from February, 2016 and completed on 25 April, 2016. The results revealed that the mulch materials significantly affected the insect pests of chilli. Among the different mulching materials tested, chilli mulched with transparent polythene and chemical insecticide Karate performed well by recording lowest population of sucking pests and larval population of *Helicoverpa armigera* and *Spodoptera litura*. The lowest number of aphids (2.70/twig), thrips (0.37/leaf), white fly (2.15/leaf), larval population of *Helicoverpa armigera* (0.72/plant) and *Spodoptera litura* (0.45/plant) were observed from chemical insecticide Karate treated plot which was closely followed by transparent polythene mulch plot. Whereas, the highest pest population of aphids (7.52/twig), thrips (3.37/leaf), white fly (6.89/leaf) and larval population of *H. armigera* (4.74/plant) and *S. litura* (2.10/plant) were recorded when no mulch material was applied to the chilli plants. However, the maximum number of natural enemy like *Cheilomenes sp* (2.85/plant) was recorded from transparent polythene mulch and the minimum numbers of these insect were recorded from chemical insecticide Karate treated plot (0.50/plant). The organic mulches like rice straw and dry banana leaf also increased the yield components of chilli. Mean yield data revealed that insecticide Karate treated plot recorded the highest red ripe chilli yield of 12.00 t/ha and it was statistically similar to both transparent plastic mulch (11.20 t/ha) and black polyethylene mulch (10.20 t/ha). The results indicated that chilli mulched with transparent polythene or application of chemical insecticide Karate 2.5 EC may be recommended for effective management of pest complex in chilli field.

Effect of different sowing dates for the management of chilli pests

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to assess the effect of varying sowing dates against insect pest of chilli. The experiment was laid out in a Randomized Complite Block Design (RCBD) with three replications. The treatments were T_1= 30 August (1st sowing); T_2= 15 September (2nd sowing); T_3= 30 September (3rd sowing); T_4= 15 October (4th sowing), T_5= 30 October (5th sowing) and T_6= 15 November (6th sowing). BARI Morich-3 was used as test crop for this trial. Depending on the maturity, the red ripe chilli was harvested from February, 2016 and completed on 02 May, 2016. The results showed that the maximum mean aphid (9.27/leaf), thrips (10.77/leaf), mite(11.51/leaf) and fruit borer population like *H. armigera* and *S. litura* larvae **(**8.25 and 6.74/plan, respectively) were found in 15 November sowing and minimum number of those insect pest were present in 30 August sowing. Red ripe chilli yields were also found to differ in descending order as follows: 30 August (13.05 t/ha)> 15 September (12.70 t/ha)> 30 September (10.30 t/ha)> 15 October (8.41 t/ha)> 30 October (5.20 t/ha)> 15 November (3.10 t/ha). It was inferred that early sowing (30 August or 15 September) resulted in lower incidence of aphids, thrips, mite and fruit borer. Such low level of insect pest caused less crop injury which resulted in enhancing the red ripe yield of chilli. So, it is suggested that for early sowing of winter chilli, the appropriate planting time may be 30 August to 15 September.

Screening of chili lines/variety against fusarium wilt disease

The study was conducted at Spices Research Center, Shibganj, Bogra during October 2015 to April 2016 to find out the resistance source of chilli lines/varieties against Fusarium wilt. The experiment was laid out in RCB design with two replications. Seventy eight (78) different chilli lines/variety (C03, C04, C05, C06, C007, C008, C0012, C0117, C0578 C0606, C01048, C02024, C002075, C003046, C03076, Jira, Bindu, Panisech, J-2, J-3, J-4, J-5, J-6, J-12, J-13, J-14, J-15, J-17, J-18, J-19, J-20, J-22, J-23, J-26, J-27, J-30, J-32, S-1, S-2, S-3, S-4, S-7, S-10, S-14, S-15, S-17, S-20, S-21, S-23, Ga-29, Ga-31, Ga-35, Ga-39, Ga-41, Ga-42, Ga-43, Ga-44, Ga-45, Ga-46, Ga-48, Ga-50, Ga-51, Ga-52, Ga-58, Ga-61, SB-5, SB-8, SB-9 SB-10, SB-11, SB-12, SB-16, SB-17, SB-19 & SB-24) and BARI Marich-3 as check were used in this experiment (J= Jamalpur, S= Sariakandi, Bogra, Ga= Gaibandha and SB= Sarisabari). The materials were collected from local, char areas and seed markets of the country. Planting was done on 27 October 2015, maintaining 40 cm x continuous sowing. Root infection and disease development by *Fusarium oxysporum* was not occurred for why no data was generated.

Post-harvest technology

Osmotic dehydration of green chilli

The experiment was conducted in the post-harvest lab of Spices Research Center, Shibgonj, Bogra to study the drying behavior of green chilli by osmotic dehydration (OD) and /or combined OD and air drying and development of dehydrated green chilli products. Fresh chilli (BARI Morich-1) was collected from the Spices Research Centre and the other materials such as salt, chemicals etc. purchased from the market. Chilli was immerse into 5, 10, 15, 20 and 25% salt solution at different temperature (10^0C, ambient, 50^0C) for different period of times, such as 2 , 4 , 6 , 8, 10, 14, 18 and 24hr as per requirement. After the end of each definite time interval the chilli was removed and quickly rinsed in water. Subsequently, surface water was removed by gently blotting with tissue-paper and dried in dryer. The rate of extent of weight loss (WL), moisture content, solid gained (SG), total solid (TS) and normalized solid content (NSC) were strongly influenced by strength of osmotic solution, immersion time and were rapid during the first 8-10 hrs of osmotic dehydration. It is seen that as the solution temperature increases, the moisture content at any given time decreases. In other words, the rate of mass transfer increases with the increase in temperature. Thus %WL, %SG, %TS and NSC increased with increasing temperature. Osmotic dehydrated chillies were dried in room, sun and oven and stored in bouem and HDPE at room temperature. The products treated in 15-25% salt and dried in room/laboratory were acceptable in all the container up to 1 year's of storage. But green chilli treated with 5-25% salt solution followed by sun dried and oven dried were acceptable in all condition for same time.

Effect of different pretreatments on quality attributes of dehydrated green chilli powder

A study was conducted in the post-harvest lab of Spices Research Center, Shibganj, Bogra to prepare green chilli powder using low cost processing technique and to study the physiochemical characteristics of green chillies powder. The number of treatments were 19 viz. T_1- 3 min blanched & treated with 1% AA solution & dried in 50ºC, T_2- 3 min blanched & treated with 0.3% NaMS solution & dried in 50ºC, T_3- 3 min blanched & treated with 0.3% NaMS + 1% $Cacl_2$ solution & dried in 50ºC, T_4- 6 min blanched & treated with 1% AA solution & dried in 50ºC, T_5- 6 min blanched & treated with 0.3% NaMS solution & dried in 50ºC, T_6- 6 min blanched & treated with 0.3% NaMS + 1% $Cacl_2$ solution & dried in 50ºC, T_7 - 3 min blanched & dried in 50ºC, T_8 - 6 min blanched & dried in 50ºC, T_9- Dried in 50ºC without blanching, T_{10}- Sun dried without blanched, T_{11}- 3 min blanched & treated with 1% AA solution & dried in 60ºC, T_{12}- 3 min blanched & treated with 0.3% NaMS solution & dried in 60ºC, T_{13}- 3 min blanched & treated with 0.3% NaMS + 1% $Cacl_2$ solution & dried in 60ºC, T_{14}- 6 min blanched & treated with 1% AA solution & dried in 60ºC, T_{15}- 6 min blanched & treated with 0.3% NaMS solution & dried in 60ºC, T_{16}- 6 min blanched & treated with 0.3% NaMS + 1% $Cacl_2$ solution & dried in 60ºC, T_{17}- 3 min blanched & dried in 60ºC, T_{18}- 6 min blanched & dried in 60ºC and T_{19}- Dried in 60ºC without blanched. The results revealed that initial vitamin C and β-carotene in green chilli were 110 mg/100g and 40 µg/g. On the other hand, the processed green chilli powder showed vitamin C and β-carotene content were 44.50 to 277.35 mg/100 g (dry weight basis) and 95.3- 108.450 µg/g respectively. For colour measurement the L*, a* and b* values in maximum treatments of green chilli powder were near about 18.0-25.0, 1.0-3.0 and 20.0-25.0. After conducting organoleptic taste, test of different treated and untreated green chilli powder packed in HDPE bag/plastic bouem and stored at RT, the results for colour, smell, pungency and overall acceptability of 19 samples showed that 3 min blanched green chilli and 3 min blanched green chilli treated with 0.3%NaMS +1% $Cacl_2$ and dried in 50^0 C (dried powder) found best among other treated and untreated sample. In order to determine the suitability of those powder in a curry, it was decided to conduct organoleptic taste test of beef curry using above 3 samples with ripe chilli powder (collected from market). It is concluded that sample S_4 (3min blanched and treated with 0.3% NaMS and 1% $Cacl_2$ and dried in 50^0C) are undoubtedly the best samples (among the samples tasted) since this sample secured the highest scores in most cases for all quality attributes (except texture, flavour) and was equally acceptable at 5% level of statistical significance and Samples S_4 however ranked between as like very much and like moderately. Though statically all the samples were equally acceptable but there were little bit differences in score among each attributes.

Effect of seed extraction method on the seed quality of chilli

The research was carried out at Spices Research Centre, Shibganj, Bogra during *rabi* to kharif-1 season, 2015-16 to identify suitable seed extraction method of chilli and to assess the effect of seed extraction method on the seed quality of chilli. The experiment was laid out in a Complete Randomized Design (CRD) with three replications. BARI Morich-3 was used as the test crop. The number of treatments were12. The treatments were categorized in three different seed extraction methods viz i) dry method ($T_{1,}$ sun drying of red ripe fruit), ii) manual seed extraction method ($T_{2,}$ extraction of seed by hand) and iii) wet method (T_3 - $T_{12,}$ fermentation of red ripe fruit for 1-10 days in water). The seeds were sown in the nursery bed on 10 October, 2015. Thirty days old seedlings were transplanted in the main field maintaining 50cm x 50cm plant spacing. The red ripe fruits were harvested on 15 April, 2016. For extracting a large quantity of seeds, it was found that the wet method was easier than the dry method or manual seed extraction method. The largest amount of seed was extracted from the treatment T_2 (112.0g/kg fruit) which was identical to T_{12} (110.1g/kg fruit), T_{11} (108.8.0g/kg fruit), T_{10} (108.3g/kg fruit), T_9 (100.5g/kg fruit), T_8 (98.2g/kg fruit), T_7 (95.5g/kg fruit) and T_6 (94.9g/kg fruit) followed by T_5 (90.25g/kg fruit) and T_1 (90.22g/kg fruit). The smallest amount of seed was extracted from T_3 (26.65g/kg fruit) treatment. On the other hand, the higher percentage of seed germination was recorded from the treatment T_3 (96%) which was identical to T_4 (95%), T_5 (90%), T_1(87%) and T_2 (85%) followed by T_6 (83%). The lower percentage of seed germination was recorded from the treatment T_{12} (1%). Also the higher percentage of seedling emergence was recorded from the treatment T_2 (67%) which was identical to T_1 (63%), T_3 (61%), T_4 (58%) and T_5 (57%) followed by T_6 (50%). The lower percentage of seedling emergence was recorded from the treatment T_{12} (0%) and T_{11} (0%). It was recorded that the germination rate was quicker for the wet method compared to dry method or manual seed extraction method. It was concluded that among the treatments of wet extraction methods the treatment T_5 was better. That means seeds should be fermented for 3 days. But the fermentation can be extended up to 4 days (T_6) depending on the firmness of pericarp of the fermented fruit. In case of small amount of fruit, it is better to use the manual seed extraction method (T_2) or dry method (T_1).

Socio-economic study

Study on production and price relationship for chilli in bangladesh

The study was conducted to aim at the determination of fluctuation, and production-price relationship of chilli in Bangladesh. The experiment was carried out by using chilli growing area, production and prices data from Bangladesh Bureau of Statistics (1985-2014). Data were analyzed using simplest method for fluctuation, and the Koyck model of distributed lag models. The study showed that the extent of annual price fluctuation of chilli was identified which was between -55 to 111 percent while the extend of fluctuation of area, production and yield ranged between -39 to 156, -27 to 161 and -17 to 55 percent, respectively during the study period. Ten several causes were identified which have been the reason of unstable price of chilli among them production swing, climatic condition and lack of storage facilities were the main causes. For preventing price fluctuation, government price control, improvement of farming and other infrastructures, provision of loan and subsidies, improvement of IT service, improvement of production technology and proper storage system are urgently needed. According to the results, chilli production in Bangladesh has been influenced by the lag value of average price formed in the market. The most striking result of the study was that the time required for the changes in the chilli prices in Bangladesh to have an effect on chilli production was 6.09 years. The value of coefficient indicated that the changes in lag values of the prices had a positive influence on production, this influence was getting smaller. To reduce the risk and uncertainty of the price of chilli which caused fluctuation more, sustainable chilli farming and establishment of an efficient marketing organization is a necessity.

Ginger

Varietal development

Evaluation of ginger germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during April 2015 to February 2016 to select the promising ginger germplasm for releasing a variety. Nineteen different ginger lines (G001, G003, G004, G0010, G0011, G0012, G0020, G0021, G0022, G0023, G0034, G0025, G0033, G0036, G0026, G0028, G0029, G0030, and G0031) with BARI Ada-1 as check were evaluated based on their yield and other characters. The experiment was laid out in randomized complete block design with three replications. The crop was planted on 10 April, 2015 and harvested on 20th February, 2016. Significantly the highest plant height number of tillers/plant, number of leaves/plant, weight of primary and secondary rhizome, and yield were observed in the line G0026. The highest yield (30.00 t/ha) was obtained from (G0026) and the lowest (11.88 t/ha) was found from G0031 line.

Regional yield trial of promising ginger lines

The experiment was conducted at Spices Research Center, Bogra (L_1), Spices Research Sub Center, Lalmonirhat (L_2) and Regional Spices Research Center, Magura (L_3) during April 2015 to February 2016. Six promising ginger lines (G005, G006, G0027, G0024, G0035 and G002) were included in the study with BARI Ada-1 as check. The experiment was laid out in randomized complete block design with three replications. The crop was planted on 10 April, 2015 and harvested on 15th February 2016. Significant differences among the ginger lines were observed in each location regarding different parameters. In case of location, the highest yield (30.42 t/ha) was recorded at SRC, Bogra, and the lowest yield was recorded (21.45 t/ha) at Magura location. In case of advance line, the highest yield (35.15 t/ha) was found from G0035 while the lowest yield (19.34 t/ha) was found from G006. The Combined effect of location × advance line gave significant effect on yield and other parameter. The highest yield (38.17 t/ha) was obtained from G0035 at Bogra location while the lowest yield (14.23 t/ha) was obtained from G006 at Magura location. Significantly higher plant height, number of tillers/plant, number of leaves/plant and secondary rhizome, dry matter (%) and yield were observed better from the line G0035. In case of combined effect, the highest dry matter (32.50 %) was found from G0035 at Bogra location. The lowest dry matter (15.83 %) was obtained from G006 at Magura location.

Induced mutagenesis on ginger for improved yield components

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2014 to February, 2016 to induce variability for yield and yield related traits of the existing ginger cultivars in Bangladesh. The healthy rhizomes of BARI Ada-1 and one promising line, G0025 were exposed to 0, 5,10 and 15 Gy doses of gamma rays from the ^{60}Cobalt source of Bangladesh Institute of Nuclear Agriculture (BINA,) Mymensingh in 2014-2015. These M_1 ginger clones were planted on 20 April, 2015 following plant-progeny-rows and harvested on 8 February, 2016. In M_1, days to 1st emergence gradually increased with increased doses of gamma rays in both the parents. The percentage of survived plants at 60 days after planting and also at harvest decreased with increased doses of gamma rays. Number of primary and secondary fingers and yield/plant increased at 5 Gy doses of gamma rays treated BARI Ada-1 and G0025 but decreased at 10 and 15 Gy doses compare to their un-irradiated controls. All the harvested M_1 ginger clones were kept in pit separately for production of M_2 generation in next year. In M_2, the percentage of survived plants at 90 DAP in 5 Gy doses of gamma rays irradiated population of BARI Ada-1 was 37 and that of the un-irradiated control was 35. In contrast, the percentage of survived plants at 90 DAP in 5 Gy and 10 Gy doses of gamma rays irradiated populations of G0025 were 57 and 62, respectively, while the un-irradiated control had 36% survival of plants. The progeny BARI Ada-1/5/10-1 derived from 5 Gy dose of gamma ray attained the tallest plants (53 cm) with maximum number of fingers (29) and rhizome weight (286g).The tallest plant (65 cm) with maximum number of leaves (239), tillers (23) and rhizome weight (458 g) was recorded from the progeny G0025/5/7-17 derived from 5 Gy dose of gamma ray. Six mutant lines of BARI Ada-1 and G0025 of 5 Gy and two lines of G0025 treated with 10 Gy were selected for further study.

Cultural management

Effect of rhizome size and seedling age on yield of ginger

A field trial was carried out at Regional Spices Research Centre, BARI, Magura during 2015-16 to standardize the suitable seed size and optimum seedling age for the successful cultivation of ginger in Jessore Region. The two factor experiment was laid out in Randomized complete Block Design with three replications . BARI Ada-1 was used as a test variety. The treatment consisted of three different seed size viz.15g, 25g and 35g and three different seedling age viz., 28, 35 and 42 days old. . The seedling of ginger and was planted in 26 May/2015 maintaining 50 cm × 25 cm spacing. The crop was harvested on 15 February 2016 after the completion of 80% pseudo stem dried. In case of individual effect, the highest yield (19.22 t/ha) was obtained from 35g seed size. In case of combined effect, the highest yield (24.43 t/ha) was recorded from 35g seed size with 42 days old seedling.

Insect pest and disease management

Screening of ginger lines/variety against rhizome rot disease complex

The trial was conducted at Spices Research Center, BARI Shibganj, Bogra during 2015-2016 to find out the resistant/tolerant lines of ginger against rhizome rot disease complex in sick plot. The experiment was laid out in a Randomized Complete Block Design with three replications. A total of twenty two (22) lines of ginger (G001, G003, G004, G0010, G0011, G0020, G0021, G0022, G0023, G0024, G0025, G0026, G0027, G0028, G0029, G0030, G0031, G0032, G0033, G0034, G0035, G0036) and a susceptible variety BARI Ada-1 as check were used in this experiment. Rhizomes were planted on 14 April, 2014 maintaining 50 cm x 25 cm spacing and harvested on 28 February, 2016. Among these lines, one line, G0035 showed moderately resistant, two lines viz., G0026 and G0027 showed moderately susceptible and twenty lines showed susceptible against rhizome rot disease complex. The highest yield (14.57 t/ha) was obtained from G0035 and the lowest yield (5.28 t/ha) was obtained from.G003.

Turmeric

Varietal development

Evaluation of turmeric lines

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2015 to February, 2016 to select promising line/ lines for releasing turmeric variety. Five lines of turmeric (T073-1, T0103-1, T0104-1, T0116 and T0119) including BARI Holud-5 were considered in this trial following RCB design with three replications. Fingers were used as planting material, planted on April 28, 2015 and harvested on February 15, 2016. Different yield contributing characters of different turmeric lines were evaluated. Significant differences were found in all lines in respect of different characters. T073-1 possessed the highest plant (105.63 cm) followed by BARI Holud-5 (100.77 cm). The maximum number of tillers/hill (8.0) was recorded from T0119, which was identical to T073-1(7.67) and T0116 (7.0). Among the studied lines, T0119 possessed the maximum number of finger (30.33), mother rhizome (4.3) while T073-1 produced the heavier finger (353.337g) with heavier mother rhizome (231.67 g). The highest yield was recorded from T073-1(22.83t) followed by T0119 (21.83t) which was statistically identical. The highest dry yield was recorded from T0119 (4.96). Most of the fingers were thin and narrow. The maximum size (length x breadth) of finger (9.43 cm x 2.0cm) was obtained from BARI Holud-5 while T073-1 possessed the maximum length of mother rhizome (9.47 cm). The core color was found attractive (Yellow- Deep yellow-orange yellow) in all lines. All turmeric lines including BARI Holud -5 having disease grade scale 1.00 for leaf blotch disease**.**

Coriander

Varietal development

Evaluation of coriander germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during *rabi* season of 2015-2016 to evaluate different germplasm of coriander collected from different sources and to identify the best germplasm for higher yield. The experiment was laid out in RCB design with three replications. Fifteen different coriander germplasm (COR01, COR02, COR04, COR05, COR07, COR08, COR09, COR10, COR11, COR12, COR14, COR15 COR16, COR17 and COR18) were evaluated with BARI Dhonia-1 as check. The seeds were sown on 11 November, 2015 and the crop was harvested on 20 and 30 March 2016. Among the germplasm, significantly the highest plant height (104.6 cm) was obtained from COR015 and the lowest (68.13 cm)was obtained from COR02. Among the lines, COR015 produced the highest seed yield (1.66 t/ha). The lowest yield was recorded from COR04 (1.11 t/ha). The heaviest 1000 seed was found from COR04 (17.40 g) and the lowest (10.20 g) was found from COR09.

Black cumin

Varietal development

Evaluation of black cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during *rabi* season of 2015-2016 to evaluate different germplasm collected from different sources and to identify the best germplasm with higher yield and other desirable characters. The experiment was laid out in RCB design with three replications. Nine different black cumin lines (BC01, BC03, BC04, BC05, BC06, BC07, BC08, BC09 and BC10) were evaluated against the recommended variety BARI Kalozira-1. The seeds were sown on 12 November 2015 and were harvested on 30 March 2016.Seed yield and other yield contributing characters were significantly different except capsule/plant and capsule length. The highest seed yield (1.057 t/ha) was recorded from BC03 which was identical to BC10 (1.007 t/ha). The lowest seed yield was recorded from BC05 (0.700 t/ha).

Fenugreek

Varietal development

Evaluation of fenugreek germplasm

The trial was conducted at Spices Research Centre, BARI Shibganj, Bogra during *rabi* season of 2015-2016 to evaluate the germplasm which was collected from different sources and to identify the best germplasm with higher yield and other desirable characters. The experiment was laid out in RCB design with three replications. Seventeen different fenugreek lines (FK01, FK07, FK08, FK09, FK012, FK014, FK015, FK016, FK017, FK018, FK021, FK022, FK023, FK024, FK025, FK27 and FK028) were evaluated against recommended variety BARI Methi-2. The seeds were sown on 13 November

2015 and were harvested on 20 March 2016.Seed yield and other yield contributing characters were significantly different among the germplasm. Among the germplasm, the highest seed yield was recorded from FK015 (1.89 t/ha). The lowest yield was recorded from FK17 (1.25 t/ha).

Nutrient and water management

Effect of integrated nutrient management (inm) on the growth and yield of fenugreek

A field experiment was carried out at Spices Research Centre, Shibganj, Bogra during two consecutive years, 2013-2014 and 2014-2015 to evaluate the effect of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.) The experiment was conducted in Randomized Complete Block design with eight treatments (viz. T_1 =Absolute control, T_2 = CF on the basis of STB ($N_{80}P_{35}K_{68}S_{18}$kgha^{-1}), T_3 = CD @ 3 tha^{-1}+ CF ($N_{53}P_{24}K_{52}S_{13}$ kgha^{-1}), T_4 = PM @ 2 tha^{-1}+ CF ($N_{52}P_{19}K_{47}S_{13}$ kgha^{-1}), T_5 = VC @ 1 tha^{-1}+ CF ($N_{67}P_{27}K_{59}S_{15}$ kgha^{-1}), T_6=CD @ 5 tha^{-1}+ CF ($N_{35}P_{17}K_{42}S_9$ kgha^{-1}), T_7=PM @ 4 tha^{-1}+ CF ($N_{24}P_3K_{26}S_9$ kgha^{-1}) and T_8=VC @ 3 tha^{-1}+ CF ($N_{41}P_{11}K_{41}S_{12}$ kgha^{-1})) and three replications. BARI Methi-2 was used as the test crop. The crop was sown on 24 November, 2013 and 17 November, 2014, respectively maintaining 40cm x 10cm spacing and harvested on 12 March, 2014 and 8 March, 2015, respectively. The result showed that the treatment T_7 (PM @ 4 t ha^{-1} + CF ($N_{24}P_3K_{26}S_9$ kgha^{-1}) produced the maximum seed yield (2.40 t ha^{-1}) which was statistically identical to T_8 (VC @ 3 t ha^{-1} + CF ($N_{41}P_{11}K_{41}S_{12}$kgha^{-1}) and T_6 (CD 5 @ ha^{-1} + CF ($N_{35}P_{17}K_{42}S_9$ kgha^{-1}). In case of stover yield, the treatment T_7 produced the highest yield (4.85 t ha^{-1}). The treatments T_7 and T_8 showed higher nutrient use efficiency along with higher N, P, K and S uptake by the plant. Application of inorganic fertilizer along with manure influenced the nutrient concentration in fenugreek seed and stover. The higher seed with N, P, K and S concentrations were observed in the treatments where poultry manure @ 4 t ha^{-1} was applied in combination with chemical fertilizers. The combined application of fertilizer and organic manure increased the organic carbon (OC %), total N, available P and available S contents in post harvest soils.

Insect pest and disease management

Management of foot and root rot disease of fenugreek

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to find out the suitable control measures in controlling foot and root rot disease of Fenugreek. The experiment was carried out following Randomized Complete Block Design with three replications. Four botanicals, three chemicals and one control were the treatment. The treatments were T_1= Seed treatment and soil drenching with Garlic extract (1:5), T_2= Seed treatment and soil drenching with Neem leaf extract (1:5), T_3= Seed treatment and soil drenching with Henna leaf extract (1:5), T_4= Seed treatment and soil drenching with Turmeric powder (0.5%), T_5= Seed treatment and soil drenching with Bavistin (Carbendazim) (0.25%), T_6= Seed treatment and soil drenching with Cabriotop (Pyraclostrobin 5% + Metiram 55% WG) (0.3%), T_7= Seed treatment and soil drenching with Provax 200 WP (Carboxin + Thiram) (0.25%) and T_8= Control. BARI Methi-2 was used in the experiment. Seeds were treated before sowing as per treatment and crop based at soil level was sprayed with the fungicides five times at an interval of 7 days from seedling stage. Treated seeds were sown on November 4, 2015 and harvested from March 20, 2016.The lowest radial mycelial growth (5.17 mm) was found in Provax 200 WP (0.25%) treated plate followed by Bavistin (0.25%) and Cabriotop (0.3%), and the highest radial mycelial growth (52.83 mm) was obtained from untreated control followed by Garlic extract (54.17 mm) and Neem extract (49.17 mm) at 7 DAI. Similar trends were observed for Radial mycelial growth at 14 DAI. Foot and root rot incidence of fenugreek under different treatments ranged from 9.66 - 35.88%, while the lowest incidence was observed in Seed treatment and soil drenching with Provax 200 WP (0.25%) and the highest incidence was observed in untreated control which was followed by seed treatment and soil drenching with Garlic extract (1:5). Seed treatment and soil drenching with Provax 200 WP (0.25%) gave the highest seed yield (1.82t/ha) which was followed by seed treatment and soil drenching with Cabriotop (0.3%) and seed treatment and soil drenching with Bavistin (0.25%), and the lowest seed yield (1.48t/ha) was recorded in control plot.

Fennel

Varietal development

Evaluation of fennel germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during *rabi* season of 2015-2016 to evaluate the germplasm collected from different sources and to identify the best germplasm with higher yield. The experiment was laid out in RCB design with three replications. Ten different fennel lines (FN01, FN02, FN03, FN04, FN05, FN06, FN07, FN08, FN09, FN10) were evaluated for yield and yield contributing character. The crop was sown on 13 November, 2015 and was harvested on 26 April 2016.Seed yield with other yield contributing characters were significantly different among the germplasm. The tallest plant was recorded from FN09 (149.4 cm) which was identical to FN02 (140.8 cm) and FN06 (141.9 cm). The higher seed yield was obtain from FN01 (1.86 t/ha) and FN06 (1.84 t/ha). The lowest seed yield was recorded from FN03 (1.07 t/ha).

Nutrient and water management

Effect of irrigation nitrogen fertilizer on the yield and yield components of fennel

A field experiment was conducted at Spices Research Centre, Shibganj, Bogra during *rabi* season, 2015-16 to identify the number of irrigations and N fertilizer rate for higher yield of fennel. The experiment was laid out in a split- plot design with three replications. Six levels of Irrigations viz., 02 irrigations at BIS+GFS, 02 irrigations at BIS+FLS, 03 irrigations at 4-5 leaf +FLS+ GFS, 03 irrigations at BIS+FLS+ G FS, 03 irrigations at 4-5 leaf + BIS +FLS and 04 irrigations at 4-5 leaf + BIS +FLS +GF stage were assigned to the main-plot and four levels of nitrogen viz., 0, 60, 90 and 120 kg/ha were assigned to the sub-plot. BARI Mouri-1 was used as a test crop. The crop was sown on 09 November, 2015, maintaining 40 cm x 10 cm spacing. Two picking were done at 06 & 10April, 2016.The highest seed yield (2.41t/ha) was obtained from 4 irrigations at 4-5 leaf + BIS +FLS +GF stage which differed significantly from other treatments. The lowest seed yield was recorded from 02 irrigations at BIS+GFS (1.32t/ha). The highest seed yield (2.35t/ha) was obtained from 120 kg N/ha which differed significantly from other treatments. The lowest seed yield was recorded from crop grown without N (1.04t/ha). The interaction between Irrigation x Nitrogen on seed yield was found significant. The highest seed yield was recorded with 4 irrigations x 120 kg N/ha (2.91 t/ha) which was identical to 4 irrigations x 90 kg N/ha (2.82 t/ha) and 03 irrigations (at 4-5 leaf + BIS +FLS) x 120 kg N/ha (2.77 t/ha). The lowest yield was obtained from 02 irrigations at BIS+GFS x 0 kg N/ha (0.72 t/ha).

Insect pest and disease management

Effect of fungicides in controlling alternaria leaf and umbel blight of fennel

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during *rabi* season of 2015-16 to find out the effective fungicides in controlling Alternaria leaf and umbel blight of Fennel. The experiment was carried out following Randomized Complete Block Design with three replications. Seven fungicides and one control were used as treatment. The treatments were T_1= Rovral 50 WP (Iprodion) @0.2%, T_2= Companion (Carbendazim + Mancozeb) @0.2%, T_3= Nativo (Tebuconazole + Trifloxystobin 100) @0.1%, T_4= Secure 600 WG (Fenamidone + Mancozeb) @0.15%, T_5= Score (Difenoconazole) @0.1%, T_6= Cabriotop (Pyraclostrobin 5% + Metiram 55% WG) @0.3%, T_7= Amistar Top 325 SC (Azoxystrobin + Difenoconazole) @0.1% and T_8= Control (Untreated). Fennel line FN 01 was used in the experiment. Seeds were sown on November 4, 2016. The fungicides were sprayed five times at an interval of 7 days from disease initiation (flowering stage). The crop was harvested from 13-16 April, 2016. Alternaria leaf and umbel blight incidence of Fennel under different treatments varied from 9.33 - 36.66%, while the lowest incidence was recorded in Secure 600 WG (0.15%) sprayed plots which was statistically identical to Rovral 50 WP (0.2%), and the highest incidence was obtained from Control plot. Secure 600 WG (0.15%) gave the highest number of seeds/plant (7659.67), weight of seeds/plant (36.11 g) and seed yield (2162.25 kg/ha) which were followed by Rovral 50 WP (0.2%) and Cabriotop (0.3%) sprayed plots, and the lowest of these parameters were recorded in Control plots.

Dill

Nutrient and water management

Effect of NPKS on growth and yield of dill

The experiment was carried out at the research field of Spices Research Centre, Shibganj, Bogra, for two consecutive years 2014-2015 and 2015-2016 to determine the standard fertilizer dose and obtaining higher yield of dill (local dill line). The experiment was laid out in a randomized complete block design with 14 fertilizer combinations comprising of four levels each of N (0, 70, 90, 110 kg/ha), P(0, 25, 35, 45 kg/ha), K (0, 50, 70, 90 kg/ha) and S (0, 10, 20, 30 kg/ha) with three replications. Dill local line was used in this trial. The crop was continuously sown on 19 November in 2014 and 21 November in 2015 respectively and harvested on 22 March in 2015 and 25 March in 2016 respectively. Response of crop to N was more pronounced in comparison to P and K. The maximum seed yield (2.4t/ha) was recorded in T_{10} ($N_{90}P_{35}K_{50}S_{20}$kg/ha) treatment which was identical to T_4, T_{11}, T_{13} and $T_{14.}$ The highest net return (Tk. 81606/ha) and benefit cost ratio (2.31) was also obtained from the same treatment T_{10} ($N_{90}P_{35}K_{50}S_{20}$kg/ha). Application of N_{90} P_{35} $K_{50}S_{20}$ kg/ha along with a blanket dose of 2 kg B, 4 kg Zn and 5 ton cow dung/ha appeared as the best treatment for maximizing the seed yield of dill.

Ajowan

Varietal development

Preliminary yield trial of two ajowan lines

The experiment was conducted at Regional Spices Research Center, BARI, Gazipur during *rabi* season of 2015-16 to assess the performance of two previously selected Ajowan lines and to select the best one in respect of yield and agronomic traits. Selected lines viz. TC GAZ 001 and TC GAZ 002 were evaluated in the field using a RCB design with 6 replications. Seeds were sown on November 16, 2015 and harvested on 7 May, 2016. There was no significant difference in respect of most of the yield and yield attributing parameters. Both the line took similar time for germination, flowering and harvesting. They also showed statistically similar plant height, number of umbels/plant, umbellule/umbel, seeds/umbellule and seed yield. The line TC GAZ 002 gave the maximum seed yield (727.5 kg/ha) while TC GAZ 001 also gave a good seed yield (664.38 kg/ha) in 2015-16. In 2014-15, TC GAZ 001 gave higher seed yield (610.0 kg/ha) than TC GAZ 002 (573.3 kg/ha). The average result of two years, TC GAZ 002 performed better giving 650.4.3 kg/ha compared to TC GAZ 001 (637.19 kg/ha).

Cumin

Varietal development

Evaluation of cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during *rabi* season of 2015-2016 to evaluate the germplasm which collected from different sources and to identify the best germplasm with higher yield and other desirable characters. The experiment was laid out in RCB design with three replications. Ten different cumin lines (CN17, CN19, CN20, CN21, CN22, CN26, CN27, CN28, CN30 and CN31) were evaluated for yield and yield contributing character. The crop was sown on 12 November 2015 and harvested on 2nd March 2016.Seed yield and yield contributing characters were significantly different among the germplasm. The higher plant height was recorded from CN17 (49.20 cm), CN19 (49.27cm), CN20 (48.27cm), CN26 (49.53 cm) and CN28 (47.80 cm) which was identical to CN21 (44.53 cm). The highest seed yield was obtain from CN26 (605.8 kg/ha) and CN28 (576.6 kg/ha). The lowest seed yield was recorded from CN19 (248.3 kg/ha).

Insect pest and disease management

Effect of fungicide in controlling alternaria blight of cumin

The experiment was conducted at Spices Research Center, Shibganj, Bogra during November, 2015 to March, 2016 to find out the efficacy of fungicide(s) for the management of Alternaria blight of cumin. The experiment was laid out in a Randomized Complete Block Design with three replications. Cumin line CN 026 was used in the experiment. Eight fungicides and one control treatment were used for this study. The treatments were T_1= Amister Top 325 SC (Azoxystrobin + Difenoconazole) @0.1%, T_2= Cabriotop (Pyraclostrobin 5% + Metiram 55%) @0.3%, T_3= Companion (Carbendazim + Mancozeb) @0.2%, T_4= Trizole 75WG (Tebuconazole + Trifroxostrobin) @0.05%, T_5 = Protect 52.2WP (Iprodione + Carbendazim) @0.2%, T_6= Rovral 50 WP (Iprodion) @0.2%, T_7 = Secure 600 WG (Fenamidone + Mancozeb) @0.15%, T_8= Deconil 500 SC (Chlorthalonil) @0.15%, and T_9=Control (untreated). The fungicides were sprayed 6 times at an interval of 8 days from disease initiation (pre-flowering stage). Seeds were sown on November 9, 2015 and harvested through March 25-30, 2016. The lowest (6.24) percent disease index (PDI) was recorded in Amister Top sprayed plots and the highest (78.81) percent disease index was recorded in control plots. The highest percent efficacy of disease control (91.77) was recorded from Amister Top sprayed plots and the lowest (48.06%) was recorded in Rovral sprayed plots followed by Protect, Secure, Trizole and Companion sprayed plots. The highest yield (467.60 kg/ha) was obtained from Amister Top sprayed plots and the lowest yield (60.03 kg/ha) was recorded in Trizole sprayed plots which was followed by Protect, Rovral and Companion sprayed plots. Control plots did not produce any seeds of cumin.

Mint

Nutrient and water management

Effect of irrigation and nitrogen fertilizer on mint production

A field experiment was conducted at Spices Research Centre, Shibganj, Bogra during *rabi* season, 2015-16 to determine the number of irrigations and N fertilizer rate for higher yield of Mint. The experiment was laid out in a split- plot design with three replications. Five Irrigations treatment viz., no-irrigation, four irrigations, six irrigations, eight irrigations and ten irrigations were assigned to the main-plot and five levels of Nitrogen viz., 0, 90, 110, 130 and 150 kg/ha were assigned to the sub-plot. The advance line of mint M001was used as a test crop. The crop was sown on 05 March, 2015, maintaining 50 cm x 25 cm spacing and harvested on 20 May, 15 July, 10 September and 05 November, 2015 respectively. In 1st harvest, the highest fresh herb yield (12.83 t/ha) was obtained from ten irrigations which differed significantly from other treatments. Similarly, the highest herb (fresh) yield (12.99 t/ha) was obtained from 150 kg N/ha that differed significantly from other N treatments. The interaction of irrigation x nitrogen showed that in first harvest, the highest fresh herb yield was recorded with ten irrigations x 150 kg N/ha (14.43 t/ha) which was identical to ten irrigations x 130 kg N/ha (13.57 t/ha) and eight irrigations x 150 kg N/ha (13.52 t/ha).In second harvest the trend of interaction was similar to first harvest. However, the highest herb yield was obtained from ten irrigations x 150 kg N/ha in case of third and fourth harvest. In pooled data, ten irrigations x 150 kg N/ha gave the highest fresh herb yield (44.63 t/ha) which differed significantly from other treatments.

Aromatic ginger

Nutrient and water management

Nutrient management for aromatic ginger (*Kaempferia galangal*)

The field trial was carried out at Regional Spices Research Centre, BARI, Magura during 2015-2016 to evaluate the response of aromatic ginger to chemical fertilizer and to find out the optimum dose of NPKS. The trial was laid out in Randomized Complete Block Design (RCB) with three replications. The treatments comprised of 14 combination of different rate of NPKS. viz. $N_0 P_{40} K_{80} S_{20}$ Kg/ha, N_{50}

$P_{40} K_{80} S_{20}$ Kg/ha, $N_{100} P_{40} K_{80} S_{20}$ Kg/ha, $N_{150} P_{40} K_{80} S_{20}$ Kg/ha, $N_{200} P_{40} K_{80} S_{20}$ Kg/ha, $N_{150} P_0 K_{80} S_{20}$ Kg/ha, $N_{150} P_{20} K_{80} S_{20}$ Kg/ha, $N_{150} P_{60} K_{80} S_{20}$ Kg/ha, $N_{150} P_{40} K_0 S_{20}$ Kg/ha, $N_{150} P_{40} K_{40} S_{20}$ Kg/ha, $N_{150} P_{40} K_{120} S_{20}$ Kg/ha, $N_{150} P_{40} K_{80} S_0$ Kg/ha, $N_{150} P_{40} K_{80} S_{30}$ Kg/ha and $N_0 P_0 K_0 S_0$ kg/ha (control). Aromatic ginger line (AG001) was used as planting material. The crop was planted in 17 May, 2015 and harvested at 20 February 2016. The highest yield 15.28 t/ha was recorded from the treatment $N_{150} P_{40} K_{120} S_{20}$ kg t/ha while the lowest yield (6.11 t/ha) was obtained from absolute control.

Plum

Cultural management

Effect of time and growth regulator concentration on success of air layering in plum

The experiment was conducted at the Regional Spices Research Center, BARI, Gazipur during June 2014 to October 2015 to standardize vegetative propagation techniques of Alubokhara (plum) and to increase success of layering using growth regulators. The experiment was conducted using a complete randomized design (factorial) using three factors comprising six time of layering (Mid April, Mid-May, Mid-June, Mid-July, Mid-August and Mid-September), two plum varieties/lines (BARI Alubokhara-1 and PD Gaz 004) and seven levels of IBA concentration (0, 1000, 2000, 3000, 4000, 5000 and 6000 ppm). The un-fruiting line PD Gaz 004 showed outstanding performance in rooting and survivability of layers over BARI Alubokhara-1. Poor rooting and lower establishment caused very high mortality of layers in BARI Alubokhara-1. Rooting and survivability, number of roots, length of roots and leaf production increased with the increasing levels of IBA concentration up to 5000 ppm. The maximum (10 out of 10) rooting success of layer with 65.83% and 59.17% establishment from PD Gaz004 was obtained when 3000 and 4000 ppm IBA was used, respectively. In BARI Alubokhara-1, the highest rooting success (3.08), establishment rate (29.42%), number of root (4.28/layer) and root length (5.08 cm) were recorded with 4000 ppm IBA concentration. June to August layering with 3000-4000 ppm IBA treatment found better for successful air layering for vegetative propagation of plums in Bangladesh.

Bay leaf

Insect pest and disease management

Seasonal variation in the population density of the gall mite within the leaf gall of bay leaf

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during May 2015 to April 2016 to study the seasonal impact on the population density of the gall mite, *Aceria doctersi* within the leaf galls of *Cinnamomum tamala*. Bay leaf line BL001were used for the study. Galled leaves were collected monthly, through random sampling and galled leaf samples were put in polythene bags and transported to the laboratory for further observation under stereomicroscope. The maximum number of mite per gall (78l) with gall size 3.0cm was recorded during the month of April then it became gradually decrease and the minimum number of mite per gall (10) with 2.1 cm gall size was recorded during the month of December. Mite population were positively correlated with average temperature (r=0.4475) and negatively correlated with relative humidity (r= -0.5366) and rainfall (r=-0.0685). Mite population was also positively correlated with percentage of leaf area damage (r=0.8585**).

Screening of bay leaf lines against leaf spot and grey leaf spot disease

The trial was conducted at Spices Research Center, BARI Shibganj, Bogra during 2014-15 and 2015-16 to find out the resistant/tolerant lines of bay leaf against leaf spot and grey leaf spot diseases. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a Randomized Complete Block Design with three replications. A total of four lines of bay leaf (CTB001, CTB002, CTB003 and CTB004) were evaluated in this experiment. In 2014-15, among these lines, one line, CTB003 showed resistant against leaf spot and grey leaf spot disease, two lines viz., CTB001 and CTB004 showed moderately susceptible against leaf spot and grey leaf spot disease and the line CTB002 showed highly susceptible against these diseases. The highest fresh leaf yield (35.02 kg/plant) was obtained from CTB004 followed by CTB003 (31.52 kg/plant). In 2015-16, among these lines, one line, CTB003 showed resistant against leaf spot and grey leaf spot disease, two lines viz., CTB001 and CTB004 showed susceptible against leaf spot and grey leaf spot disease and the line CTB002 showed highly susceptible against leaf spot disease whereas susceptible to grey leaf spot disease. The highest fresh leaf yield (36.03 kg/plant) was obtained from CTB004 followed by CTB003 (34.07 kg/plant) but the result was identical.

Cinnamon

Varietal development

Evaluation of cinnamon germplasm

The study was conducted at Regional Spices Research Center, BARI, Gazipur during May, 2014 to May, 2016 to evaluate the tree growth, leaf characteristics, bark thickness, specific bark weight and dry matter of bark of the present cinnamon plants. Descriptive statistics on 34 different parameters showed variations among 50 cinnamon accessions (CZ GAZ 001 to CZ GAZ 050). Different growth parameters with tree volume differed plant to plant. Higher coefficient of variation was found for base girth, main stem height, number of tertiary branches/plant, tree volume, fresh and dry bark weight of tertiary branches was observed. Bark thickness and specific bark weight gradually declined from main stem to lateral branches. The hierarchical cluster analysis with single scaled Dendrogram showed clustering due to variation among the germplasm. Cluster III contained maximum number of genotypes (14) followed by cluster I and cluster VII, each having 10 genotypes. Significant positive correlation of fresh bark thickness of main stem with fresh bark thickness of primary, secondary and tertiary stems and also with fresh and dry bark weight of main, primary, secondary and tertiary stems. Specific bark weight had also significant correlation with fresh and dry bark weight of main, primary, secondary and tertiary barks.

Betel leaf

Varietal development

Evaluation of betel leaf germplasm

This experiment was conducted at Spices Research Center, BARI, Shibganj, Bogra during 2014-15 and 2015-16 to select the promising betel leaf germplasm for releasing a variety. The land was medium high and the soil was sandy loam in texture. Twelve different betel leaf genotypes (BL 001, BL 002, BL 003, BL 004, BL 005, BL 008, BL0010, BL0012, BL 0016 and BL 0021) along with BARI Paan -1 and BARI Paan -2 (as check) were evaluated based on their yield and yield contributing characters. The experiment was laid out in a Randomized Complete Block Design with three replications. In 2014-15, among the germplasm, the highest (232.80 cm^2) leaf area was recorded from BL003 and the lowest (140.70 cm^2) was recorded in BL002 during *kharif-2* season. In case of *rabi* season, the highest leaf area (196.90 cm^2) was recorded from BL003 and the lowest leaf area (121.20 cm^2) was recorded in BL0016. The maximum number of leaves (41.62 lakh/ha/years) was recorded from BL003 and the minimum number of leaves (29.01 lakh/ha/years) was recorded from BL008. The highest leaf (fresh) yield (23.27 t/ha/years) was recorded from BL003 and the lowest leaf (fresh) yield (11.85 t/ha/years) was recorded from BL002 and BL008. In 2015-16, among the germplasm, the highest (218.60 cm^2) leaf area was recorded from BL003 and the lowest (130.60 cm^2) leaf area was recorded from BL002 during *kharif-2* season. In case of Rabi season, the highest leaf area (180.50 cm^2) was recorded from BL003 and the lowest leaf area (117.20 cm^2) was recorded from BL0016. The maximum number of leaves (40.52 lakh/ha/years) was recorded from BL003 and the minimum number of leaves (27.25 lakh/ha/years) was recorded from BL002. The highest leaf (fresh) yield (21.58 t/ha/years) was recorded from BL003 and the lowest leaf (fresh) yield (11.22 t/ha/years) was recorded from BL002.

6 VEGETABLE CROPS

Eggplant

Varietal improvement

Genetic diversity of eggplant germplasm during winter season

The study was conducted with seventeen eggplant germplasm at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2015-16. The collected germplasm originating from different local and exotic sources were subjected to cluster analysis. The germplasm were constellated into four distinct groups with the range of 3 germplasm in cluster II to 6 germplasm each in cluster I. The inter-cluster distance in all cases was larger than the intra-cluster distance. Maximum inter-cluster distance (14.547) was observed between germplasm of cluster II and III followed by cluster II and III (13.569) and minimum was found between germplasm of cluster I and IV (5.830). The highest intra cluster value (1.29) was observed in cluster III. Mean performance of different clusters revealed that cluster I recorded the highest fruit weight/ plant (4.00kg), fruit diameter (8.65 cm), average fruit weight (164.45g), fruit yield (52.00t/ha). Therefore, inbreeds belong to cluster I, cluster II and cluster III would be given higher priority for crossing in future eggplant hybridization programme.

Collection and evaluation of eggplant germplasm for summer season in Jamalpur region

Twelve eggplant germplasm were collected and evaluated at RARS, Jamalpur during the summer season of 2015. The highest (50.5) number of fruits per plant was noted from the line SMJam010 and the lowest (3.5) number of fruits per plant was noted form the line SMJam011. The maximum yield (13.25 t/ha) was produced by the line SMJam013 and the minimum yield (3.25t/ha) was produced by the line SMJam007.

Collection and evaluation of eggplant germplasm for winter in Jamalpur region

Thirteen eggplant germplasm were collected and evaluated at RARS, Jamalpur during winter season of 2015-2016. The highest (63) number of fruits per plant was noted from the line SMJam016 and the lowest (9) number of fruits per plant was noted form the line SMJam017. The maximum yield (34.70 t/ha) was produced by the line SMJam011 and the minimum yield (14.7 t/ha) was produced by the line SMJam017.

Collection and evaluation of eggplant germplasm for winter in Ishurdi region

Performance of twenty three eggplant germplasm out of thirty six collected from Ishurdi region were investigated at Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2015-16. Most of the germplasm gave satisfactory yield ranged 39.02-71.74 t/ha. However, the highest marketable yield (71.74 t/h) was recorded from SM Ish-013 and the lowest yield (41.76 t/ha) from SM Ish-026.

Performance trial of eggplant lines for summer

A study on the performance of fourteen eggplant lines/ variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2015. The line SM011 took minimum 94.7 days to first harvest. BARI Begun 8, BARI Begun 10 produced the longest fruit (25.0 cm), while SM191B produced maximum diameter fruit (6.00 cm). The line SM011 produced the highest marketable fruit number per plant (36.33) and the lowest (11.33) was produced by SM057. The line SM200 produced the heaviest fruit (124.6 g). The control variety BARI Begun 10 produced significantly highest yield (31.18 t/ha) closely followed by SM220 (29.42 t/ha), SM200 (28.95 t/ha), SM011 (27.67 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in SM204B (9.95%) followed by SM191B (10.3%). The results of the present study revealed that five green coloured lines (SM011, SM048, SM204B, SM220, SM221B) and two purple coloured lines (SM200 and SM217) were found promising for earliness, high yield, pest tolerance, fruit shape, fruit colour and may be recommended for PYT in the next year summer season.

Performance trial of eggplant lines for winter

The study was conducted with 12 eggplant lines/ variety at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2015-16 to select suitable lines for releasing as open pollinated eggplant variety. The lines varied significantly for their response to all characters. The line SM269A required minimum days to first harvest which was 94 days. Maximum fruit number was obtained by SM284B (39.72), which was followed by 2M284A (31.72) and BARI Begun 9 (28.67). The heaviest fruit was harvested from SM267 (201.2 g) identical with SM268 (189.8 g). The yield range of eggplant lines was 35.53 - 53.73 t/ha. The maximum fruit yield was recorded from the line SM284B which was statistically similar with SM284A (51.13 t/ha) and SM275 (50.70 t/ha), while the range of fruit infestation by BFSB was 9.24% (SM262) - 20.66% (SM282). Considering the yield contributing parameters studied six lines viz., SM284B, SM284A, SM275, SM267, SM269A and SM282 were found promising and may be recommended for PYT.

Preliminary yield trial of eggplant lines in winter

The study was conducted with 16 eggplant lines/varieties at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2015-16 to select suitable lines for releasing as open pollinated eggplant variety. The lines varied significantly varied for their response to all characters. The line SM236C required 80 days to first harvest which was identical with SM 232 (81days) and SM23AC (81). Maximum marketable fruit number was obtained by SM236A (31.0), which was followed by SM232 (29.00), SM254 (28.67). The heaviest fruit was harvested from BARI Begun 6 (223.9 g). The yield range of eggplant lines was 30.94-51.13t/ha, while the highest fruit yield (51.13t/ha) was recorded from the check variety BARI Begun 6 which was followed by SM236 A (49.95t/ha), SM236 C (50.47 t/ha). The range of fruit infestation by BFSB was 12.52-27.81 %, while minimum infestation was in SM236. Considering the yield contributing parameters studied three lines SM236A, SM236C and SM232 were found promising and may be recommended for AYT.

Advanced yield trial of eggplant lines for winter

A study on the performance of six selected advance eggplant lines with BARI Begun 4 and BARI Begun 6 was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the winter season of 2015-16. The line SM217A took the minimum (80 days) to first harvest and delayed harvesting variety was BARI Begun 6 (110 days) which was identical to SM206 (107 days). The variety BARI Begun 4 and the line SM206 produced the maximum identical marketable fruit number (37), where BARI Begun 6 produced the minimum number (21). The variety/ line BARI Begun 4, SM217A, SM191B produced the maximum identical fruit weight per plant (4.52 kg, 4.48 kg, 4.46 kg, respectively), while the lowest fruit weight per plant (3.40 kg) was recorded from SM204. The highest average fruit was obtained from BARI Begun 6 (187.90 g) while the lightest fruit was from SM206 (102.8 g). Minimum infestation by fruit and shoot borer was observed in SM217A (12.48%). Maximum identical higher yield (58.80, 58.28 and 58.07t/ha) was produced by BARI Begun 4, SM 217A and SM 191B respectively. The results raveled that the lines SM206, SM217A and SM191B were found promising for earliness, high yield and pest resistance and may be recommended for RYT.

Regional yield trial of eggplant lines for winter

Two advanced eggplant lines SM 233 and SM 216 including one check variety BARI Begun 4 were evaluated at four locations of BARI research stations, during winter season of 2015-16 to observe their yield and yield potentiality at different locations. On an average, the advanced line SM 233 possessed the highest number of marketable fruits (37.8) per plant followed by SM 216 (35.2) and the lowest in check variety BARI Begun 4 (28.2). The corresponding yield was also highest in case of the line SM 233 (39.11 t/ha) followed by SM 216 (37.47 t/ha) and lowest was in check variety BARI Begun 4 (36.80 t/ha).

Journey of Bt eggplant in Bangladesh

Eggplant is a very popular vegetable which is grown year round all over Bangladesh. The eggplant shoot and fruit borer is the key pest of eggplant in this country. For eggplant production, farmers spray insecticides over 100 times in a season at 2-3 days intervals, which are most harmful for public health and environment. The production cost of eggplant is increased due to frequent spraying of insecticides. The farmers cannot successfully control this insect by using conventional IPM methods. By this time it was not possible to develop variety resistant to eggplant shoot and fruit borer by conventional breeding. So to overcome this problem, the Bt gene (Cry1Ac) was introgressed in 9 popular eggplant varieties. Bangladesh Agricultural Research Institute created a multidisciplinary team in 2005 with biotechnologist, plant breeder, soil scientist, plant pathologist and entomologist under ABSPII Project which is led by Cornell University of USA and funded by USAID. Multilocation field trials were conducted in seven research stations of BARI (Joydebpur, Jamalpur, Jessore, Hathazari, Barisal, Ishwardi and Rangpur) from 2008-2013 according to the permission of the Ministry of Environment and Forests and Ministry of Agriculture and approval of Bio-safety Committee and following the bio-safety rules. After conducting a series of research for more than 8 years following the existing rules of the country, BARI applied to National Technical Committee on Crop Biotechnology (NTCCB) to release Bt eggplant. Then the application was sent to the National Committee on Bio-safety (NCB) with the recommendation of NTCCB. Upon proper assessments by NCB based on the recommendation of Bio-safety Core Committee, Government approved the deregulation of four Bt eggplant varieties [BARI Bt begun-1 (Uttara), BARI Bt begun-2 (Kazla), BARI Bt begun-3 (Nayantara), and BARI Bt begun-4 (ISD 006)] on 30 October, 2013 following the existing rules of the country.

Tomato

Performance of BARI released tomato varieties at northern region during late winter

A study on the performance of BARI released tomato varieties at northern region during late winter was carried out at ARS, Thakurgaon during *kharif-1* 2016 cropping season in order to compare the performance of BARI released tomato varieties and farmers' collected hybrid tomato lines at northern region of Bangladesh. Eight tomato varieties/lines were included for comparison. The varieties/lines were: BARI Tomato 2, BARI Tomato 9, BARI Tomato 14, BARI Tomato 15, BARI Tomato 17, Line 848, Utsab and Ruma VF in a RCB design with three replications. The results revealed that number of fruits (11.10) and fruit yield per plant (500.08gm) was recorded the highest in BARI Tomato 14 and fruit size (42.44cm^2) and individual fruit weight (155.16gm) was recorded the highest in BARI Tomato 17 compared to farmers' preferred line 848, Utsab and Ruma VF. From the study it is also clear that BARI Tomato 14 gave the maximum yield (25.04 t/ha) closely followed by the line 848 (20.85 t/ha).

Advanced trial for dual purpose processing/fresh market tomato inbred lines

An experiment was conducted to study the advanced trial of tomato inbred lines for yield, diseases resistance and shelf life with AVRDC supplied inbred tomato lines having processing quality for selecting superior inbred tomato lines at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), BARI, Gazipur, Bangladesh during the winter season of the year 2015-16. There were four selected inbred tomato lines (selected from the AVRDC supplied eight inbred tomato lines) viz.: SL0033=CLN3670B; SL0036= CLN3552C; SL0037=CLN3552B; and SL0038=

CLN3125L-5x65 along with one local check (AVTO01139) was included in this study. The findings of major parameters revealed that days to 50% flowering was observed uniform and earlier than control that was confined in 46-48 days. It may be due to the genetic potentiality as the lines are inbreeds. In respect of fruit number per plant varied from 36 to 49, while the highest number of fruit (49) was counted in the line control as because it was genetically good fruit bearer type and the lowest number of fruits was counted in CLN3552B (36). In the case of average fruit weight, the largest fruit was harvested from CLN3552B (91.67g) followed by CLN3552C (87.66g) and the smallest average fruit weight were obtained from CLN3670B (83.33 g). The length and diameter of fruits of different lines also varied significantly. The marketable fruit yield per plant varied from 2.42 to 2.66kg. The highest marketable fruit yield per hector was obtained from control (66.94 ton/ha) while other lines also exhibited statically identical quantity of fruit per hector. All the lines showed good resistance on EB, LB, TYLCV, BW, FW, SB and TFB. In respect of postharvest attributes, all the lines specially control line showed satisfactory magnitude lightness, hue angle, TSS, firmness, dry matter percentage, P^H and vitamin-C for fresh product. The same lies also showed better performance in terms of lightness, hue angle, pulp percent, final product percent and viscosity too in processed product. Considering the growth habit, diseases infection rating, shelf life, qualitative traits and yield, all lines found to be promising and may be put into regional yield trial (RYT) in the following year to confirm the results.

Regional yield trial of multiple disease tolerant AVRDC tomato lines

A regional yield trail (RYT) of five multiple disease tolerant tomato lines of AVRDC with check BARI Tomato 15 was conducted at the experimental field at three different farm of Bangladesh Agricultural Research Institute (BARI) during the winter season of 2015-16. The highest average number of fruits (36.00) was counted in the line AVTO 1229, also the highest yield were obtained from the same line which was 98.19 t/ha. This was the 1st year RYT. The experiment will be repeated for further confirmation.

Regional yield trial of tomato lines for processing

A regional yield trial (RYT) of four processing tomato lines of AVRDC with check BARI Tomato 3 was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC) and at six regional agricultural research station (RARS) of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of 2015-16. Satisfactory number of fruits per plant was recorded from the all AVRDC lines which were ranged from 30-36. The highest fruit yield per hectare was obtained 64.88 tons from the line AVTO-01139. One of the main criteria of processing tomato is viscosity, which was ranged from 2.50 to 3.70 Cp in AVRDC lines while highest value (7.05 Cp) showed in BARI Tomato-3. The line AVTO01139 was found better in respect of yield and processing quality (viscosity).

Regional yield trial of T_y gene inserted tomato lines for yield and diseases resistance

A regional yield trial (RYT) of five selected potential tomato lines of AVRDC with check BARI Tomato 15 was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC) and at five regional agricultural research station (RARS) of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year of 2015-16. The maximum fruit yield (66.52 tones) per hectare was obtained from the line SL0008. Virus infection was recorded ranged from 1-3 % and no bacterial wilt infection was found to occur.

Regional yield trial of T_y gene inserted cherry tomato lines for yield and diseases resistance

A regional yield trial(RYT) of two selected cherry tomato lines of AVRDC and one advance cherry tomato line with check BARI Tomato-11 was conducted at the experimental field of Olericulture Division, Horticulture Research Centre (HRC) and at five RARS of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year of 2015-16. The maximum fruit yield per hectare (43.31 tones) was obtained from the line SL0012. Virus infection ranged from 1-4% and no bacterial wilt was found to infect. The beta-carotene content showed higher in the line SL0012

(227µg), while the second highest recorded in SL0011 (204µg) and the lowest bete-carotene exhibited from the line SL0067 (113µb).

Regional yield trial of selected semi-determinate tomato lines

A regional yield trial of two selected semi-determinate type tomato lines with BARI Tomato 14 as check was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC) and at more six regional agricultural research station (RARS), Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year 2015-16. The Maximum fruit yield per hectare between two lines was variedd ranged from 57.48 to 58.22 tons.

Regional yield trial of selected beta carotene rich tomato lines

Regional yield trial (RYT) were conducted at different locations (Four RARS) of BARI with included Joydebpur, Akbarpur, Iswardi and Hathazari in the winter season of 2015-16 to evaluate the performance of selected beta-carotene rich tomato lines. Selected three beta-carotene rich tomato lines viz. SL0201, SL0203 and SL0205 were selected for this study with BARI Tomato 7 was considered as check. The lines were identical for their response to marketable fruits per plant (MD/Pl), and marketable yield per hectare (MY/ha) when data of different locations were combined. All the lines had closer MF/Pl (31-35) as the check variety (44) at combined data. The check variety BARI Tomato 7 produced higher yield (83.54 t/ha) compared to all other lines (68.88 to 75.69 t/ha) at combined data. The lowest degree of virus infection was observed in SL0201 (4.16%), while the highest (8.33%) virus infection was recorded from the tomato line SL0205. Therefore, the experiment may not be repeated to next year.

Cauliflower

Evaluation of cauliflower germplasm

The study was conducted with seventeen collected germplasm from different sources (both local and exotic) and BARI released variety (BARI Fulcopi 1 and BARI Fulcopi 2) at the experimental field of Olericulture Division, HRC, BARI, Gazipur during October 2015 to January 2016 to find out the the suitable sowing time with yield performance. In respect of days to 50% curd initiation earliness were found in BOB-024-1, BOB-020-2, BOB-010-1, BOB-019-2 and BOB-020-1(63-65 days) and others were delayed which ranged 70-78 days. The most delayed line was BOB-022-1(78 days). Early curd harvested lines were BOB-010-2, BOB 020-1, BOB 020-2 and BOB 024-1 and range was 73-77 days and the delayed lines were BOB 022-1 (89 days) and BOB 018-1 (99). Bigger size single curd was obtained from BOB 022-2 (720 g) and the lowest from BOB 019-2 (236g). Based on 50% curd initiation, days to curd harvest and marketable yield all lines were categorized into three groups. The results revealed that six lines were early required up to 77 days, thirteen lines/ two varieties were medium, required over 80 days and the rest two lines were late and required over 90 days. On the basis of marketable curd weight (g) all the lines were categorized into three groups viz., high (above 750 g), medium (500-750 g) and low (under 500 g). Six lines and 2 varieties were yielded higher, ranging 770-1233 g, nine lines produced medium yielded, ranging 575.0-650.0 g and rest of two lines produced lower yield, ranging 372.0-425.0 g.

Purification of BARI Fulcopi 1 (Rupa) variety through mass selection

The study was conducted with BARI Fulcopi 1 population at the experimental field of Olericulture Division, Horticulture Research Centre, BARI, Gazipur during the winter season of 2015-2016 to purify degenerated population for original varietal characters. The segregating population of BARI Fulcopi 1 (check) and the selected population to its original type were used as planting material in this study. In respect of days to 50% curd initiation and days to curd harvest of selected population required average 75 days to curd initiation and 86 days to first curd harvest, while BARI Fulcopi 1 required 79 days to curd initiation and 91 days for curd harvest. Almost similar numbers of leaves were observed in both the population, average 16 and 17 leaves were recorded in selected population and BARI Fulcopi 1, respectively. Average leaf length (53.5 cm) and breadth (59.2 cm) were recorded in selected population while leaf length (47.5 cm) and breadth (68.6 cm) were recorded in BARI Fulcopi 1. The longest curd length (17.6 cm) and breadth (10.4 cm) were also recorded from selected degenerated population, which contributed to produce higher single curd yield in the selected population. Comparatively higher marketable curd weight (910 g) was produced by the selected population while (805 g) was by BARI Fulcopi 1. Considering single curd weight selected population produced higher curd wt. (720 g) but BARI Fulcopi 1 produced (610 g). The average yield (24.48 t/ha) from degenerated population while BARI Fulcopi 1 was (20.70 t/ha). Moreover, creamy whitish color and compact curd was observed in the selected population which indicates the original varietal character of BARI Fulcopi 1. Selection was further made within the selected population for advancing the generation to purify the variety having homogeneity of BARI Fulcopi 1.

Regional yield trial of advanced early cauliflower lines

The experiment was conducted with two advanced cauliflower lines with one check variety (Maradona) at six locations of BARI which included Joydebpur, Ishurdi, Jamalpur, Jessore, Norshindi and Comilla during 2015-2016 to observe the performance of advanced cauliflower lines at early winter season. In average of four locations, the line CL-0171 and CL-0172 required (90 and 86 days) and local check Maradona required 95 days to curd harvest. Among the two advanced lines, CL-0172 produced heaviest marketable curd (233.83 g), while the line CL-0171 (294.90g) and Maradona produced (355.33g) marketable curd weight. The highest calculative per hectare yield (11.86 t) was recorded from the line CL-0172 and the line CL-0171 produced (9.61t) while check variety Maradona produced (16.85t). Considering the overall performance the advanced line CL-0172 is being proposed to release as an early open pollinated (OP) cauliflower variety.

Broccoli

Advanced yield trial of selected broccoli lines

The experiment was conducted at the research field of Olericulture Division, Horticulture Research Centre, BARI, Gazipur during the winter season of 2015-2016 with two selected open pollinated (OP) broccoli lines with BARI Broccoli 1 as check to evaluate their yield performance. In respect of days to 50% curd initiation the line BOI-002 took the lowest days (45.25) to 50% curd initiation followed by BOI-014 (51.25) while the variety BARI Broccoli 1 took the longest days (57.75) and in respect of harvest time BARI Broccoli 1 took the longest days (64.75) followed by the line BOI-014 (59.50) and the line BOI-002 took the shortest days (56.50) to curd harvest. The highest curd length (13.33 cm) was recorded from the line BOI-002 which was identical with BARI Broccoli 1while the shortest length (8.86 cm) was recorded from BOI-014 but in case of curd breadth no significant difference was observed. The highest marketable curd wt. (595.80g) was recorded from the line BOI-002 followed by the line BOI-014 (590.90g) and lowest was from BARI Broccoli 1 (558.50g).The highest only curd weight (438.30g) was obtained from the line BOI-002 followed by the line BOI-104(402.80g), while the lowest was (398.50g) from BOI-002. The highest whole plant wt. (1.20kg) was recorded from BARI Broccoli 1 which was identical with BOI-002 (1.15kg) and the lowest was from BOI 014 (0.97kg). The highest curd yield (23.83t/ha) was recorded from the line BOI-002 followed by the line BOI-014 (23.64t/ha) and the lowest yield (22.34t/ha) was recorded from BARI Broccoli 1.On the basis of earliness, uniform curd shape, compactness and yield both the line performed good but considering in qualitative character the line BOI-014 showed better. So both the line may be recommended for regional yield trial for next year.

Cucurbits

Evaluation of F_9 progenies of bitter gourd in summer season

Eleven bitter gourd lines of F_9 progenies were evaluated with two check varieties BARI Karala1 and commercial Hybrid Tia at the experimental field of Vegetable Division, HRC, BARI, Gazipur in the summer season of 2015. Objective of the study was to select suitable lines for using in bitter gourd breeding program. Lines varied significantly for their response to days to 1st female flower open (DFF), node order of first female flower open (NFF), male-female sex ratio (M:F), fruits per plant (Ft/plant), average fruit weight (AvFtWt), fruit length (Fl), fruit diameter (FD), vine length (VL), number of primary branches per plant (NoPriBr) and per cent fruit fly infestation (FtflyInfest) ($P<0.05$).Lines were similar for duration of fruit harvest (DH), yield/plant and yield/ha($P>0.05$). Among others, DFF varied from 12-40, NFF 9-30, M:F 1 to 8, Ft/plant 22-98, AvFtWt 39.7-126g, FL 12-23.8cm, FD 3.1-5.0cm, vine length 340-765.5cm, NoPriBr 48-87 and FtflyInfest 17.3-58.2%. Male-female ration (M:F) was absolutely narrow (1:1 to 8:1) indicating high female tendency of all the lines. Four lines AVBG 1308, 1324, THMC143 and THMC167 produced higher fruits (53-98/plant) over the check varieties (44-53/plant). Two lines AVBG1301 and THMC167 were either similar or higher yielder (26-31.5t/ha) relative to the check variety BARI Karala 1 (27.2t/ha).Linear model indicated NoPriBr significantly correlated with fruits/plant ($P=0.017$).Four lines had lower FflyInfest (17.3-26.7%) compare to check varieties. No infection of powdery mildew and leaf spot diseases was observed in the lines. All the lines were free from virus diseases (0.0% incidence) except one (5.6% incidence) under field condition. Wide variation was observed in the lines for different morphological characteristics. Considering quantitative characters; visual observation of fruit color, shape and size; and insect, and disease reactions nine lines excluding AVBG 1304 and 1327 were found promising for using in future breeding program of bitter gourd.

Off season evaluation of bitter gourd germplasm

Twenty-four bitter gourd germplasm of indigenous sources were evaluated with two check varieties BARI Karala-1 and commercial Hybrid Tia at the experimental field of Olericulture Division, HRC, BARI, Gazipur in the winter season of 2015-2016 to select suitable genotype for off season production. Germplasm varied significantly for their response to days to 1st female flower open (DFF), male-female sex ratio (M:F), duration of fruit harvest (DH), fruits per plant (Ft/plant), yield/plant, yield/hectare, average fruit weight (AvFtWt), fruit length (FL), fruit diameter(FD), vine length (VL), number of primary branches per plant (No.PriBr) and per cent fruit fly infestation (FtflyInfest) ($P<0.05$) while they were similar for node order of1stfemale flower open (NFF)($P>0.05$).Of these, DFF varied from 17-54, M:F 2:1-7:1, Ft/plant 13-41, yield/plant 0.6-5.4kg, yield/ha 3.5-29.5 tons, AvFtWt 23.3-189.4g, FL 6.7-25.9cm, FD 3.3-5.0cm, VL 322.5-830.0cm, No.PriBr 41-89/plant and FtflyIfest 2.5-9.5%. Among different characters, 20 germplasm were early relative to DFF (17-31), 23 produced higher Ft/plant (14-41), 15 higher yield/plant (2.3-5.4kg), and 15 higher yield/ha (12.5-29.5 tons) over the check varieties (32-38, 13-15, 1.7-2.2kg and 9.6-12.0 tons respectively). M:F of germplsm was absolutely narrow (2:1 to 7:1) than the desirable label (15:1). Linear model indicated non-significant relationship between VL and yield/plant. Similar non-significant relationship was evident between NoPriBr with fruits/plant and yield/plant. Twelve germplasm showed low bitterness and eight mediums. Lower FtflyInfest was observed in nine germplasm (2.5-4%) while others higher (4.5-9.5%). Eighteen germplasm showed highly resistant (HR) reaction (0.0% incidence) while the rest resistant (R) (8.3-25% incidence) to viruses. Similarly, four germplasm showed HR reaction, eight R, 11 moderately resistant (MR) while one moderately susceptible (MS) to powdery mildew (PM) disease. Wide variation was observed among the eight pure lines for morphological characters. Considering all the characters studied, virus and PM reaction and visual observation of fruit shape, size and color three pure lines (MC115-1(C)-9-12, 115-1(C)-9-4 and 117-1-2-3) were found promising as varieties which may be put into regional yield trial in off-season. Beside, eight genotypes (MC122, 124, 125, 126, 129, 130, 131 and 132) were found promising which may be advanced for making them homozygous off-season potential lines.

Regional yield trial of advanced bitter gourd lines

Five lines of bitter gourd were evaluated with one check variety BARI Karala 1 at different regional locations of BARI during the summer season of 2015 to select suitable lines for release as variety. Fruits/plant of test lines varied from 28-54 over the locations and 35-45 at combined data. Check variety ranged from 25-34 over the locations and combined data for this character. In general, check variety had higher average fruit weight (AvFwt) (112.8-116.2g) than the lines across the locations and combined data (72.3-98g). Four lines AVBG 1301, THMC 143, BT 117-1-3 and 117-1-2 performed more or less well for yield/plant at individual locations and combined data (3.7-4.7, 2.8-3.9, 2.8-4.5 and 2.6-4.4 kg respectively). Performance of three lines AVBG 1301, THMC 143 and BT 117-1-3 was good for yield/hectare across the locations and combined data (24.1-25.7, 20.5-21.6 and 18.8-24.7 tons respectively) compare to check variety (15.7-22 tons). No incidence of virus disease (0.0%) was recorded in the lines. Based on the quantitative characters; visual observation of fruit color, shape and size; and virus reactions three lines BT 117-1-3, THMC 143 and AVBG 1301 were found promising which may be released as open pollinated (OP) variety of bitter gourd.

Advanced yield trial of selected winter bottle gourd lines

The trial was conducted at the experimental field of Olericulture Division, HRC, BARI, Joydebpur during winter season of 2015-16. Eleven advanced lines of bottle gourd were included in the study to select superior lines with higher yield, better quality and maintain simultaneously increase the seeds of the selected lines. The lines varied significantly for their response to fruit number per plant, average fruit weight (kg), fruit yield (kg/plant), fruit length (cm), fruit diameter (cm) and fruit yield (t/ha). The line LS151C produced the earliest fruiting with 71.67 days as well as the maximum number of fruits per plant (12.25). The range of fruit length was 23.00 cm (LS146A1) - 43.67 cm (BARI Lau 4), while fruit diameter range was 10.87 cm (LS148-5) - 15.00 cm (LS139A5). The maximum fruit yield (t/ha) was recorded in the line LS151C (48.00 t/ha) which was statistically similar with LS146A1 (46.34 t/ha), LS139A1 (46.00 t/ha), LS137A5 (45.08 t/ha), LS133A4 (41.72 t/ha). Considering earliness, high yield, fruit color and acceptable fruit size, shape, 4 advanced lines LS151C, LS146A1, LS139A1, LS137A5 were found promising and may put under AYT.

Regional yield trial of winter bottle gourd lines

One advanced bottle gourd line and one check variety were evaluated at seven locations of BARI research stations during winter season of 2015-16 to observe their yield and yield potentiality at different locations. On an average, the advanced line LS 0026-5-3 possessed the highest number of marketable fruits (12) per plant than the check variety BARI Lau 3 (10).The corresponding yield was also higher in case of the line LS 0026-5-3 (56.50 t/ha) than the check variety BARI Lau 3 (44.58 t/ha). The fruit size and shape and colour (deep green) of the fruit was found good in the advanced line LS 0026-5-3.

Evaluation of pumpkin lines during winter season at hill valley

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2015-16 to find out the suitable pumpkin lines to release as a variety and to utilize in future breeding program of pumpkin. Experimental lines varied significantly for their response to days to 1st flowering (DFF), node order of first female flower (NFF), fruits per plant (FPP), fruit length (FL), fruit girth (FG), flesh thickness (FT), individual fruit weight (IFW), yield and TSS (%). Of these, DFF ranged from 92.5-75.3, NFF 11.8-18.5, FPP 6.8-2.3, FL 11.7-27.6, FG 50-73, FT 3.1-5.0, yield (t/ha) 20.1-9.7 and TSS (%) 6-9.2. Minimum node order of first female flower (11.8) was observed in CMRai003. The highest yield (20.1 t/ha) was found in CMRai006 followed by CMRai008 (19.2 t/ha) and lowest (9.7 t/ha) was found in CMRai009 treatment.

Advanced yield trial of winter pumpkin

Five promising pumpkin lines were subjected to advanced yield trial at the experimental field of RHRS, Patuakhali during the winter season of 2015-2016. Among the lines, CMPK 10/1, CMPK 18/2 and CMPK 22 was found promising. CMPK 10/1 produced highest yield with highest TSS.

Inbred development of summer pumpkin (S_5-S_6)

The experiment was conducted to advance the S_5 summer pumpkin generation to S_6 generation to get pure inbred line. Most of the lines showed uniformity with little difference in various morphological characters. It indicates that the lines approaching towards homogeneity.Again there was wide variation among the lines. Selected lines will be advanced from S_6 to S_7 in summer, 2016 for further purification and evaluation.

Collection and evaluation of ridge gourd germplasm

A study on the performance of ten ridge gourd lines with BARI Jhinga 1 as a check was conducted at the research field of Olericulture division, HRC, BARI during the summer season of 2015-16. The lines LA 1013 showed the earliness in respect to duration of harvest. The marketable fruit number/plant ranged from 42 (LA 1011) to 16 (LA 1016) which was corresponding to the marketable fruit yield/plant trait. The line LA 1015 produced the highest yield (28.97 t/ha), whereas, the lowest yield was observed in the line LA 1016 (17.09 t/ha). Based on the duration of harvest, marketable fruits /plant, Marketable fruit yield /plant, fruit length and fruit diameter, the lines LA 1010, LA 1011, LA 1012, LA 103, LA 1014, LA 1015, LA 1018 and LA 1019 were found promising for the preliminary yield trial in the next year.

Evaluation of ridge gourd (*Luffa acutangula*) germplasm

An experiment was conducted at Regional Horticulture Research Station, BARI, Lebukhali, Dumki, Patuakhali with 28 germplasm of ridge gourd with BARI Jhinga 1 as check variety, during summer season of 2015 to evaluate the performance. Among the germplasm, BD 2972, BD 2975, BD 2999, BD 3000 and BD 3031 found promising in respect of yield and quality.

Evaluation of sponge gourd genotype

An experiment was conducted at Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the summer season of 2014-15 to evaluate the performance of ten sponge gourd genotypes. The genotypes were BD 1677, BD 1699, BD 1711, BD 1733, BD 2362, BD 2363, BD 2364, BD 2369, BD 2380 and BD 2382. Wide ranges of variability were found in the studied characters among the genotypes. Maximum total number of fruits per plant was found from BD 1699 (34.75) which were statistically similar to all other genotypes except BD 2363 which perform the minimum number of fruits (25.17). BD 2382 genotype provided maximum marketable yield (7.00 kg/plant) which was at par with all other genotypes except BD 2362 (5.05 kg/plant) and BD 2363 (4.79 kg/plant). BD 1677, BD 1699, BD 2364, BD 2369, BD 2380 and BD 2382 genotypes showed better performance in respect of number of fruits/plant, fruit diameter, yield/plant and some other characters. So above lines may consider for next year trial.

Observational yield trial of sponge gourd lines in summer

A study was conducted to observe sponge gourd lines in respect of yield and quality at HRC field, RARS, Jamalpur during the summer season of 2015. Two sponge gourd lines viz. LC-001 and LC-002 were evaluated to investigate the yield and yield contributing characters. The higher number of fruits per plant (47.00) was produced by the line LC-001 whereas the lower number of fruits (46.00) was noted from the LC-002. The higher individual fruit weight (209.54 g) noted in the line LC-002 and lower (164.98 g) in the line LC-001. The more fruit yield per plant (6.29 kg) & per hectare (27.96 t) was produced by the line LC-001 as against the less 5.28 kg & 23.48t in the line LC-002, respectively.

Advanced yield trail of ash gourd

The study was conducted with five ash gourd lines at the research field of Olericulture division of HRC, BARI, Gazipur during summer season of 2015-16. The days to 1stfemale flowering opening earlier in BH001 (36.80days) followed by BH002 (37.33days), late in BH027 (42.03days). Days to 1st harvest was earlier in BARI-Chalkumra 1 (50.13days) followed by BH027 (51.20 days) and BH027 (52.10days) and late in BH029 (54.58days).The number of fruits/plant was highest in BARI Chalkumra 1 (8.9) followed by BH00 (8.0) lowest in BH027 (6.35). Individual fruit weight was higher in BH001 (1.75 kg) and followed by BH029 (1.68) and lower in BARI Chalkumra-1(1.45kg). Fruit length was highest in BARI chalkumra-1 (21.25cm) followed by BH001 (18.75cm) and BH029 (18.35cm) lowest in BH027 (16.98

cm). Fruit diameter was highest in BARI chalkumra-1 (9.9) followed by BH029 (8.72 cm) and lowest in BH027 (6.67cm). The yield per plant was higher in BH001 (14.0kg) followed by BH029 (13.24 kg) and lowest in BH027 (10.15kg). Among the advanced lines yield (t/ha) was highest in BH001 (46.23 t/ha) followed by BH029 (47.67 t/ha) and lowest in BH027 (33.49 t/ha).

Advanced yield trial of selected melon lines

Fourteen muskmelon lines were selected and conducted an evaluation trial at the research field of Olericulture Division, Horticulture Research Centre, BARI during the season of 2015-2016. Significant variation was observed in all traits accept days to harvest and fruit breadth. The line CM 014-3-6-1 took the highest days (54) to harvest while the line CM 013-5-1 took the lowest days (44) to fruit harvest. The highest number of fruits per plant (13) was recorded from the line CM013-6-1, followed by CM011-5-5 and CM 014-5-4 (11) and the lowest from the line CM 015-5-2-1 (5.5). The highest fruit yield per plant (50.20 kg) was recorded from the line CM 014-5-4, which was statistically similar to CM 013-5-1 (46.5 kg) and CM 011-5-5 (49.7 kg). Maximum TSS (%) was obtained from the line CM 015-2-3(5.0). Considering all the characters the lines genotypes CM 014-5-4, CM 013-5-1, CM 011-5-5 and CM 013-6-1 may be selected for advanced yield trial.

Collection, characterization and evaluation of teasle gourd germplasm

The study was carried out at the experimental field of Olericulture Division, Horticulture Research Centre, BARI, Gazipur, Bangladesh to evaluate the performance of teasle gourd germplasm for yield and quality and development of promising teasel gourd lines for future breeding program. Sixteen genotypes were evaluated during the summer season of 2015. Observation on different morphological and yield attributing characters were recorded from five randomly selected plants from each germplasm. Considering the yield contributing characters and fruit qualities the germplasm MD001, MD005, MD006, MD009, MD010 can be selected for further observation. The outcome of the study will be useful in the development of teasel gourd lines having high yield potential with attractive size and color which meeting the consumer’s choice.

Regional yield trial of selected cucumber lines

The experiment was conducted with two selected cucumber lines including one commercial variety as check at four different locations across the country which included Joydebpur, Jamalpur, Akbarpur and Narshingdi during February to June 2015 for their yield and quality. On an average, the line CS 0079 had the highest number of marketable fruit (13.00) per plant followed by the line CS 0080 (11). The corresponding average yield was also highest in CS 0079 (19.54 t/ha) followed by CS 0080 (17.08 t/ha). Considering yield, fruit colour, shape, size, virus incidence and insect infestation both the lines showed better performance for developing a new variety.

Regional yield trial of squash lines

A study on the performance of four advanced squash lines along with a check Bulam House was conducted at three different locations throughout the country during winter season of 2015-2016. Among the test lines, the line CP 0004 showed highest potentiality with respect to ultimate average fruit number per plant (4.9). The corresponding yield was highest against yield performance in case of CP 0003 (40.12 t/ha) followed by the check line CP 0003 (38.19 t/ha).

Legumes and other vegetables

Advanced yield trial of early hyacinth bean lines

The study was conducted to evaluate the selected early hyacinth bean lines with check variety BARI Sheem-1 at the research farm of Olericulture Division, HRC, BARI, Joydebpur, Gazipur during winter season of 2015-16 to observe their yields and yield potentiality. The lines differed significantly for their response to all most all the characters including check variety. In case of days to 50% flowering, the selected line MZ Black 2 produced flower earlier (72 days) followed by the line CB 0160 (84 days), while the check varieties BARI Sheem 1 needed longer times for flowering (153 days). The maximum number of pods per plant (650) was produced by the check variety BARI sheem-1which was statistically similar with the line MZ Black 2 (498). The check variety gave the highest pod yield (16.92 t/ha) while lowest in CB 0160 (9.37t/ha). Considering higher yield, earliness and quality of pods the lines MZ Black 2 and CB 0160 may be selected for further evaluation to develop as an early high yielding hyacinth bean variety.

Evaluation of yard long bean lines

The study was conducted at the research farm of Olericulture Division, HRC, BARI, Gazipur during *kharif* season of 2015 to evaluate some selected yard long bean germplasms including BARI Borboti 1 as check. The test lines including check variety differed for their response to all the traits. In case of days to 50% flowering the lines VS 42 blossomed earlier (29 days), followed by VS 20 (30 days), VS 43 (30 days) and VS 45 (32 days) while the line VS 21 flowered late (41 days). The highest number of pods per plant was obtained from the line VS 21 (47) while the lowest in VS 34 and VS 42 (16).The line VS 21 produced the maximum weight of pods per plant (598.52 gm) and the line VS 43 produced the minimum (277 gm). The highest yield was found in the line VS 21 (23.94 t/ha) due to higher yield attributes while the lowest yield from VS 42 (8.92 t/ha).

Regional yield trial of French bean lines

An experiment was conducted to observe the performance of an advanced French bean (khaishya) line PVRai005 with check variety BARI Jharsheem 3 at five different locations of BARI research stations during the winter season of 2015-16. The advanced line PVRai 005 and the check variety BARI Jharsheem 3 produced similar seed yield (4.90 t/ha and 4.74 t/ha respectively). Wide variation was observed among the locations in respect of green seed yield per hectare on an average. The check variety BARI Jharsheem- 3 produced higher yield (2.26 t/h) which was followed by the advanced line PVRai 005 (1.65 t/h) in Akhbarpur. Among the locations, in Hathazari both the advanced line and check variety showed the best yield potentiality. Moreover, the color, shape and attractiveness of the bold seed of the advanced line is superior than the check variety.

Evaluation and selection of okra (*Abelmoschus esculentus* L. Moench) lines for yield and virus resistance

A preliminary yield trial involving 168 okra genotypes in comparison to four check varieties viz. BARI Dherosh-1, BARI Dherosh-2, Green Soft F1 and Aleya was conducted according to augmented design at Regional Horticulture Research Station, Bangladesh Agricultural Research Institute, Lebukhali, Patuakhali during Summer, 2016. The analysis of variance indicated non-significant differences among blocks whereas significant differences were among all checks for single fruit weight, fruit length, number of fruit per plant and yield. Many selections were higher performer for yield and its components in prevailing environmental conditions then the best check variety. Fruit yield varied from 93.78 g plant^{-1} to 998.06 g plant^{-1} and 3.71 t ha^{-1}to 39.51 t ha^{-1}. However, among the check, only BARI Dherosh-1 showed virus susceptibility, but among the test genotypes, 67 showed different degree of virus reaction.

Regional yield trial of okra

Four lines of okra were evaluated with BARI Dherosh 1 as check at different regional stations of Bangladesh Agricultural Research Institute during March- July 2015 to evaluate their yield performance and reaction against yellow vein mosaic virus (YVMV). Fruit yield of the selected lines were ranged from 13.48-19.34 t/ha over the locations with the mean value of 16.22 t/ha. The line AE 086 produced higher average fruit yield (19.34) than other lines including BARI Dherosh 1. Among the locations, the yield performances of the selected okra lines were highest in Jamalpur and the lowest in Jessore. In Joydebpur location, fruit borer infestation was less in AE 086 (1.3%) compared to other selected lines. The selected lines showed highly resistant to yellow vein mosaic virus in all the location but in Jessore AE 012 and AE 018 showed highly susceptible along with BARI Dherosh 1. In general, the line AE086 was found to be high yielder as well as highly resistant to YVMV and it was recommended for release as new variety of okra as BARI Dherosh 2.

Regional yield trial of spinach lines

The study was conducted with two advanced spinach line and BARI Palongshak 1 as a check at the five locations which included Joydebpur, Jamalpur, Jessore, Akbarpur and Ishurdi during winter season of 2015-2016. The highest average leaf weight per plant (111.5 g) was recorded from the line SO-0047, while the lowest (99.84 g) was from BARI Palongshak 1. The highest average number of leaves 14.80 was observed from the line SO-0048 and the lowest 13.60 from BARI Palongshak 1. Among the tested lines of five locations, the highest average per hectare yield (22.87 t) was recorded from the line SO-0047 followed by BARI Palongshak 1 (20.76 t) and the lowest yield (22.15 t) was recorded from SO-0048. Considering yield and late bolting nature the line SO-0047 may be selected to release as a variety.

Collection, evaluation and conservation of indigenous vegetables

Thirty types of underutilized indigenous vegetables (12 vegetables, 16 medicinal) were put under observational trial to assess their performance in respect of yield, seed production and agronomic practice for growing different time of the year during 2015-16. The yield potentiality of Bathua - green (17.32 t/ha), Bathua - red (19.70 t/ha), Thankuni (1.60 t/ha), NafaShak (5.20 t/ha), Pudina (3.15 t/ha), Nunia (16.75 t/ha), Malancha (7.90 t/ha), Helencha (5.60 t/ha), Shialmutra Shak (16.85 t/ha), Shaknotey (21.30 t/ha), Katanotey (23.10 t/ha) and Pat Shak (1.25 t/ha). Effort on growing of telakucha through seed and vine cutting at three times of the year was under trial. It was observed that means of propagation as seed is not feasible but vine cutting as means of propagation is suitable for year round production of telakucha. However, further studies are required for the standardization of their production practices. More, fifteen types of indigenous medicinal herbs have been collected and are being multiplying for further study.

Collection, evaluation and characterization of drumstick germplasm

A study on collection and evaluation of drumstick germplasm was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the season of 2010-12 to onward and this year (2015-16), a study on evaluation of selected seven drumstick lines was conducted. The drumstick line MO 0025 found to be as seasonal natured having good quality with individual pod weight (61.53g), while four lines viz MO 0001(1), MO 0007, MO-0008, MO-0011 and MO-0012 are considered as off-seasonal promising lines having 40-50g, average individual pod weight. Yearly average per plant yield indicated that the lines MO 0001(1) exhibited maximum yield (12.75 kg) followed by line MO 0012 (13.23 kg) and line MO 0011. These lines are capable to produce flower two to three times in a year. No major pest and diseases was found to attack in the Moringa lines.

Regional yield trial of open pollinated carrot lines

The study was conducted with two advanced carrot lines and a check at the four different locations which included Joydebpur, Jessore, Ishwardi and Jamalpur during the winter season of 2015-2016, to evaluate the performance of two promising lines selected on the basis of root and seed production potentiality. Each line was grown separately to find out the superior line having good seed production potentiality, Marketable root yield was obtained from the two lines. CR 0014 scored the highest root yield per hectare (22.79t) followed by CR 0009 (16.35 t/ha). There were no diseases and pest infestation of the two lines during the growing period. Considering the performance of studied characters both the lines CR 0009 and CR 0014 may be put under trial as RYT for 2nd year for variety development.

Evaluation of stem amaranth lines

The experiment was carried out at the research field of HRC, RARS, Hathazari, and Chittagong during the summer season of 2016. Plant height was higher in Am Hat-01 (132 cm) than BARI Danta 1(127 cm). Individual plant weight was also much higher in Am Hat-01 (714 g) than BARI Danta 1(572g). Yield per square meter and yield per hectre were higher in Am Hat-01(6.6kg and 65.5 ton) than BARI Danta 1(4.9 kg and 49.6 ton).

Hybrid development of vegetables

Performance of eggplant hybrids for winter

A study on the performance of twenty four eggplant hybrid / variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 20015-16. The released variety BARI F1 Begun 4 took minimum 97.5 days to first harvest. The hybrid F_1 19x216 produced the longest fruit (26.25 cm), while F_1 21x13 and F_1 21x223 produced maximum diameter fruit (8.7 cm). The F_1 14x216 produced the highest marketable fruit number per plant (48.50) and the lowest (19.50) was produced by F_1 21x13. The hybrid F_1 21x13 produced the heaviest fruit (206.8 g). The F_1 14x216 produced significantly highest yield (64.35 t/ha) which was at per with F_1 5x8 (62.01 t/ha), F_1 14x8 (60.25 t/ha), F_1 220x221B (60.16 t/ha), F_1 21x221B (59.80 t/ha), F_1 21x223 (58.69 t/ha), F_1 48x221B (57.65 t/ha). Minimum infestation in eggplant fruit and shoot borer was observed in F_1 14x216 (8.50%) which was at per with F_1 77Bx216 (9.00 %), F_1 48x221B (9.16 %), F_1 19x216, F_1 220x221B (9.50 %). The results of the present study revealed that eight green coloured hybrids (F_1 3x229, F_1 21x13, F_1 21x221B, F_1 21x223, F_1 48x221B, F_1 191Bx259, F_1 204Ax221B, F_1 220x221B) and six purple coloured hybrids (F_1 1x216, F_1 5x8, F_1 14x8, F_1 14x216, F_1 18x216, F_1 19x5) were found promising for earliness, high yield, pest tolerance, fruit shape, fruit colour and may be put under trial for PYT in the next year summer season.

Preliminary yield trial of eggplant hybrids for summer

The study on the performance of nine eggplant hybrids/ variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2015 to develop high yielding F_1 eggplant varieties suitable for summer season cultivation. The lines varied significantly ($P<0.05$) for their response to all character except fruit diameter. The hybrid 19x4 took minimum 94.33 days to first harvest and also produced the longest fruit (17.30 cm), while F_1 15x5 produced maximum diameter fruit (6.00 cm). The line F_1 3x9 and BARI F_1 Begun 4 produced the highest marketable fruit number per plant (33.67) and the lowest (13.67) was produced by F_1 19x203. The line F_1 19x203 also produced the heaviest fruit (138.6 g). The hybrid F_1 19x14 produced the highest yield (30.90 t/ha) which was statistically similar F_1 3x9 (30.51 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in F_1 19x14 (12.57%). The results of the present study revealed that three hybrids viz., F_1 3x9, F_1 15x5, F_1 19x14 were found promising for earliness, high yield, pest tolerance, fruit shape, fruit colour and may be put under trial for AYT in the next year summer season.

Preliminary yield trial of eggplant hybrids for winter

The study was conducted with 18 eggplant F_1 lines/varieties at the experimental field of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during 2015-16 to select suitable F_1 lines for releasing as hybrid eggplant variety. The lines varied significantly for their response to all characters. The F_1 222Bx233 required minimum days to first harvest (86.50 days). Maximum marketable fruit number was obtained by F_1 1x233 and F_1 14x233 (44.50), statistically similar with F_1 236Ax233 (42.50). Heavy sized fruit was harvested by BARI F_1 Begun 2 (143.3 g) followed by F_1 18x233, BARI F_1 Begun 4 (136.9 g). The yield range of eggplant lines was 49.21 -59.80 t/ha. The maximum fruit yield was recorded from the line F_1 4x203 which was statistically similar with F_1 4x203 (59.67 t/ha), F_1 18x233 , BARI F_1 Begun 4 (58.83 t/ha), F_1 1x233 (54.60 t/ha), F_1 5x203 (56.07 t/ha), F_1 5x233 (56.62 t/ha), F_1 14x233 (55.33 t/ha), F_1 19x203 (57.65 t/ha), F_1 19x233 (54.43 t/ha), F_1 222Bx233 (57.14 t/ha), while range of fruit infestation by BFSB was 8.63% (F_1 14x203) - 13.20 % (BARI F_1 Begun 4). Considering the yield contributing parameters of studied lines, ten hybrid lines F_1 4x203, F_1 4x203, F_1 18x233, F_1 1x233, F_1 5x203, F_1 5x233, F_1 14x233, F_1 19x203, F_1 19x233, F_1 222Bx233 were found promising and may be put under trial for AYT.

Advanced yield trial of eggplant hybrids for summer

The study on the performance of four advanced eggplant hybrids was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2015. The hybrid F_1 3x203 took minimum 101.3 days to first harvest. The line F_1 1x19 produced the highest marketable fruit number per plant (27.67) and the lowest (17.67) was produced by F_1 3x203. The line F_1 21x13 produced the heaviest fruit (140.1 g). The hybrid F_1 1x19 also produced the longest fruit (17.18 cm), while F_1 21x13 produced maximum diameter fruit (7.20 cm). The hybrid F_1 21x13 produced significantly highest yield (35.66 t/ha) closely followed by F_1 1x19 (33.50 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in F_1 1x19 (11.40%). The results of the present study revealed that two hybrids viz. F_1 21x13 and F_1 1x19 were found promising for earliness, high yield, pest tolerance, fruit shape, fruit colour and may be put under trial for RYT in the next summer season.

Advanced yield trial of eggplant hybrids for winter

An evaluation with six F_1's lines/ varieties was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2015-16. The lines varied significantly ($P<0.05$) for their response to the all characters studied. In respect of days to 1st harvest the earliest hybrid was F_1 5x11 (82.00 days), while the delay harvested hybrid was BARI F_1 Begun 3 (96.67 days). The highest marketable fruit number per plant (43.33) was recorded from BARI Hybrid Begun 4 followed by F_1 5x11 (38.67), while F_1 13x12 produced the lowest (31.33). BARI Hybrid Begun 3 produced the longest fruit (25.73 cm) followed by F_1 20x5 (22.50 cm), F_1 3x9 (21.33 cm), while shortest fruit was produced by F_1 5x11 (10.70 cm). Maximum diameter fruit was produced by F_1 5x11 (7.36 cm) which was statistically similar with BARI F_1 Begun 4 (7.10 cm), F_1 20x5 (7.06 cm), F_1 13x12 (7.03 cm), while minimum was obtained by BARI F_1 Begun 3 (3.70 cm). The heaviest fruit weight was (149.30 g) was harvested from F_1 13x12, while the lowest was harvested from BARI Hybrid Begun 3 (100.0 g). Significant highest yield (68.90 t/ha) was produced by the check variety BARI F_1 Begun 4 which was statistically similar with $F_1$13x12 (61.10 t/ha), $F_1$5x11 (58.07 t/ha) and followed by $F_1$3x9 (55.47 t/ha), while the least was in BARI F_1 Begun 3 (48.53). Minimum infestation was in BARI Begun 3 (10.03) by fruit and shoot borer which was statistically similar with BARI F_1 Begun 4 (12.38 %) and $F_1$13x12 (12.91 %). Considering earliness, higher yield, pest tolerance, fruit shape and colour, 3 hybrids viz., $F_1$13x12, $F_1$5x11 and $F_1$3x9 were found promising, selected and may be recommended for RYT for the next year winter season

Regional yield trial of eggplant hybrids for winter

A study on the regional yield performance of three advanced eggplant hybrids was conducted at five experimental farm of BARI during the winter season of 2015-16 to observe their yield and yield potentiality. On an average, the advanced hybrid line F_1 14x5 possessed the highest number of marketable fruits (20.8) per plant followed by F_1 1x19 (18.0) and the lowest in check variety BARI F_1 Begun 2 (15.6). The corresponding yield was also highest in case of the line F_1 14x5 (46.07 t/ha) followed by BARI F_1 Begun 2 (39.16 t/ha) and F_1 1x5 (36.07 t/ha) and the lowest was in F_1 1x19 (33.87 t/ha). Considering earliness, higher yield, pest tolerance, fruit shape and colour, two hybrids viz., F_1 14x5 and F_1 1x5 were found promising. So it may be recommended that the hybrid line F_1 14x5 may be proposed for release as a new hybrid variety.

Advanced trial of tomato hybrids for yield, diseases resistance and shelf life

The experiment was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), BARI, Gazipur, Bangladesh during the winter season of the year 2015-16 to study the yield performance and shelf life along with pest and diseases reaction. The AVRDC supplied four selected hybrid tomato lines viz.: SL0022 (CLN3946), SL0024 (CLN3948), SL0025 (CLN3949) and SL0027 (CLN3954) along with one local check (BARI Hybrid Tomato 9) were included in this study. The tomato lines differed significantly in most of the parameters studied. The major parameters revealed that: fruit number per plant varied from 41 to 57, while the highest number of fruit (57) was counted in the line CLN3948 as because it was genetically good fruit bearer type and the lowest in CLN3949 (41). In the case of average fruit weight, the largest fruit was harvested from BARI hybrid Tomato 9 (97.92g) followed by CLN3948 (93.57g) and the smallest from CLN3949 (79.37g). The length and diameter of fruits of different lines also varied significantly. The marketable fruit yield per plant varied from 1.90 to 3.35 kg while the lines CLN3946, CLN3948 and CLN3949 contributed identical fruit yield. The highest marketable fruit yield per hector was obtained from CLN3948 (84.30 tons) while the second highest yield (81.37 tons) by CLN3946. All the AVRDC lines showed good shelf life (18 to 20 days). Satisfactory magnitude of Vit.-C content and firmness of fruits were also exhibited from the same lines and that was 17.70µg – 18.70µg and 1.69-2.91kg-F, respectively. Virus and wilt resistance was also shown in the same lines. Therefore, theses lines may be selected for putting into regional yield trial to confirm the results.

Preliminary yield trial selected of F_1 tomato lines

A study on performance of six hybrids was conducted at the experimental field of Olericulture Division of HRC, BARI during winter season of 2015-16 to evaluate the yield potentiality. The treatment T_7 produced the largest individual fruit weight (73g), the same treatment produced maximum yield per plant (4.10kg) followed by 3.44kg harvested from control. Maximum yield per ha was obtained from T_7 (78.08t) followed 73.24t contributed by the new hybrid line T_6. Considering the yield performance and other attributes the treatment T_6 (P_5xP_7), T_7 (P_5xP_8) and T_8 (P_6 xP_8) may be selected for put in to advanced yield trial to confirm the results.

Heterosis in summer tomato

The study was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in the summer season of 2015. Ten hybrids of summer tomato and their parents were included in this study to estimate heterosis relative to mid parent (MP) and heterobeltiosis (BP), and select better hybrids. Both positive and negative heterosis was observed for different quantitative and qualitative characters of summer tomato. Three hybrids S12Hybrid-54, 60 and 61exhibited significant positive heterosis relative to MP for marketable yield per plant (MY/pl) (420.0**, 11.9* and 130*% respectively), average fruit weight (AvFWt) (46.3**, 39.8* and 34.5*% respectively), TSS (29.8**, 7.1 and 0.6 respectively) and marketable yield per hectare (MY/ha) (422.1**, 11.9 and 134.9*%*, respectively). Similarly, S12Hybrid 54 and 61 showed significant positive heterobeltiosis for MY/pl (424.5** and 51.1% respectively), AvFWt (37.2** and 26.1*%, respectively) and MY/ha (386.4** and 68.1*% respectively). Highly significant positive heterosis relative to BP was also recorded in S12Hybrid 54 for TSS (27.3**%). Based on the characters studied for MP heterosis and heterobeltiosis, visual looking of fruit and plant health at least three hybrids S12Hybrid 53, 54 and 61may be selected for testing in regional yield trials.

Regional yield trial of hybrids of tomato in summer

The study consisting of three hybrids and BARI Hybrid Tomato 4 and 8 as check varieties was conducted at four locations of BARI which included Joydebpur, Potuakhali, Hathazari and Jamalpur in the summer season of 2015-16. But, data of only Joydebpur and Potuakhali locations were combined for interpretation. All the test hybrids produced similar or lower marketable fruits per plant (MF/plant) (15-17) compare to the check varieties (15-21) at combined locations. Average fruit weight (AvFwt) was higher in all the test hybrids (65.3-80.2g) than the check varieties (44.8-61.7g) when the data of both locations were combined. They also produced higher marketable yield per hectare (Myield/ ha) (35.7-43.4 tons) over both of the check varieties (27.5-31.1 tons). Maximum yield was recorded in WS11 Hybrid 3 (43.4 t/ha) while minimum in the checks (27.5-31.1 tons/ha). Virus incidence was lower in all the hybrids (2.6-2.9%) than the check variety BARI Hybrid tomato 4 (8.6%). Incidence of bacterial wilt was minimum in all the hybrids including checks (0.7-2.3%). Considering all the parameters studied, necessary steps can be taken for releasing WS11 as hybrid variety.

Regional yield trial of pumpkin hybrids

The experiment was conducted with four hybrids and one check variety BARI Hybrid Mistikumra 1 at Joydebpur, Akbarpur, Ishurdi, Potuakhali and Pahartali locations of BARI during the winter season of 2015-16. Fruits per plant of test hybrids ranged from 3-9 while check variety 4-10 over the locations. All the hybrids including check had more or less family size fruit (1.8-4 kg). Most of the test hybrids produced higher yield at different locations compare to the check variety. Of these, yield of Hybrid 26 was consistent over the locations. Three hybrids (Hybrid 21, 26 and 28) produced higher yield at combined locations (34.1, 37.2 and 38.5 t/ha respectively) compare to check variety (33.6 t/ha). Hybrid 26 ranked 2nd for yield but it had higher TSS (8.8%) and deep orange flesh colour which indicates good quality of this genotype. Visual looking of inside and outside of fruit of Hybrid 26 among others was attractive. Three hybrids including check variety had no virus incidence (0.0%) while two 6.7 and 20% incidence. Considering all the parameters studied, Hybrid26 was found promising as variety.

Regional yield trial of ridge gourd hybrids

The experiment was conducted at different regional locations of BARI during the summer season of 2015. Three hybrids of ridge gourd and BARI Jhinga 1 were evaluated to select superior hybrid (s) with higher yield and better quality for release as variety. Hybrid genotypes varied for their response to fruits/plant, AvFwt and yield/hectare which ranged from 15-35, 137.3-170.0g, and 12.6-25.4 tons respectively across the locations whereas these characters ranged from 21-30, 148.2-157.3g and 15.4-23.4 tons at combined data. Hybrid 1, performed better for all the yield and yield contributing characters at individual locations (Fruits: 27-35/plant, Yield: 20.1-25.4 tons/ha) and combined data (Fruits: 30/plant, Yield: 23.4 tons/ha) compare to rest of the genotypes at individual locations (Fruits: 15-27/plant, Yield: 12.6-20.6 tons/ha) and combined data (Fruits: 21/plant, Yield: 15.4-17.2 tons/ha). Per cent fruit fly infestation was lower in all the hybrids (2.6-7.8%) than BARI Jhinga 1 (8.1%). No virus disease (0.0% incidence) was observed in any of the genotypes under field condition. Considering all the parameters studied and visual looking of fruit, Hybrid 1 was found promising which may be released as a hybrid variety of ridge gourd.

Advanced yield trial of capsicum hybrids

This study of two selected F_1's of capsicum ($F_1$1x2, $F_1$2x3) with a check was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2015-16. The hybrid 2x3 took the minimum days to 1st harvest (66.25 days). The highest number of fruits per plant (28.40) was recorded from $F_1$1x2. The heaviest fruits (114.8g) were obtained from F_1 2x3. Fruit weight per plant was found maximum (2.54kg) in $F_1$1x2 followed by the $F_1$2x3 (1.42kg). The highest yield was produced by $F_1$1x2 (57.05 t/ha) due to higher yield contributing characters. Minimum infestation by fruit borer (1.02%) was observed in $F_1$1x2, This hybrid line also performed well against white fly and mite infestation. All the studied lines were differed in various colors, which are varied from red to yellow in matured stage. These two hybrids ($F_1$2x3, $F_1$1x2) were found promising for earliness, high yield, color variation and insect pest reaction. So these two lines may be recommended for further evaluation for their yield and quality.

Production technology

Effect of plant growth regulator on growth and development of summer tomato

This study was conducted to evaluate the effect of different plant growth regulators on the growth and yield of BARI Hybrid Tomato 8 during summer season. The experiment consisted of ten types of plant growth regulator (PGRs) viz. $T_{1=}$ Control (No application of plant growth regulators), T_2=25 ppm GA_3, $T_{3=}$ 50 ppm GA_3. $T_{4=}$ 100 ppm GA_3, $T_{5=}$ 125 ppm GA_3, T_6= 0 ppm GA_3+ RD of Tomato tone, $T_{7=}$ 25 ppm GA_3+ RD of Tomato tone, $T_{8=}$ 50 ppm GA_3+ RD of Tomato tone, $T_{9=}$ 100 ppm GA_3+ RD of Tomato tone and T_{10}= 125 ppm GA_3+ RD of Tomato tone were used in this experiment. The maximum plant height was observed from the treatment T_4 (120.1cm).The maximum number of fruits/plant (31.33), individual fruit weight (81.80 gm) as well as yield per hectare was obtained from the plant which was treated with 50 ppm GA_3 (T_3) and Recommended dose of Tomato tone whereas the minimum was recorded from control plants.

Screening of different tomato varieties in saline area of Bangladesh

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2015-16 to screen out saline tolerant tomato variety and to popularize BARI developed tomato varieties in saline areas. There were nine tomato varieties viz. BARI Tomato 2, BARI Tomato 14, BARI Tomato 15, BARI Tomato 16, BARI Tomato 17, BARI Hybrid Tomato 5, BARI Hybrid Tomato 8, BARI Hybrid Tomato 9 and local/company variety (cheek) included in this study. BARI tomato 17 gave the highest fruit yield (71.07 t/ha) and Satkhira local had the lowest fruit yield (38.31 t/ha). The lowest level of soil salinity was recorded in sowing time (3.65 ds/m) and the highest level of salinity (10.15 ds/m) was recorded at the harvesting stage.

Vine pruning technique for higher production of bottle gourd varieties/lines in winter

The experiment was conducted at the research field of Olericulture Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the winter season of 2015-16 with three bottle gourd varieties/lines (BARI Lau-3, BARI Lau-4, LS 0030) and three pruning level to observe the effect of pruning on the maximization of vine production in bottle gourd. The maximum vine yield (14.24 t/ha) was recorded from the line LS 0030 when the vines were pruned at three side vine stage. (V_3P_2) which was statistically with same line when the vines were pruned two side vine stage (V_3P_1). The lowest vine yield was recorded from BARI Lau-3 (8.80t/ha) when it was pruned at three side branch stage (V_1P_2). The findings of the study showed that line LS 0030 along with pruning of terminal shoots two vine stages can be recommended for better vine production in bottle gourd for use as leafy vegetable.

Standardization of planting and harvesting time on yield of broccoli

The experiment was conducted at the research field of Olericulture Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the winter season of 2015-16 to standardize the planting time as well as the suitable curd harvesting time. This was the two factored (Factor 1= 3 Planting time and Factor 2= 3 harvesting time after curd initiation) replicated on RCB design. The material was used here is BARI Broccoli 1. The seedlings of the Broccoli when planted in 1st October in the main field and harvesting was done when the curd attained 8 days after initiation (P_2H_1) gave the highest yield (21.61 t/ha).Whereas the lowest yield was obtained from the interaction of P_3H_2 (18.36 t/ha). The findings of the study showed that planting on 1st October with harvesting curd at 8, 10 and12 days after curd initiation was found better in Broccoli cultivation.

Effect of different nutrient on tomato production in pot under rooftop gardening

An experiment was conducted at Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 2015-16 to develop a production package of fertilizer for tomato production under rooftop. Eleven treatment combinations were made with organic and inorganic fertilizer combinations viz.:T_1= Absolute control; T_2= Recommended fertilizer dose (RD); T_3= 50% soil +50% kitchen waste compost; T_4= 50%soil + 50% kitchen waste compost+75% RD; T_5= 50% soil + 50% kitchen compost + 50% RD; T_6= 50% soil + 50% vermicompost; T_7= 50% soil + 50% vermicompost + 75% RD; T_8= 50% soil + 50% vermicompost +50% RD; T_9= 50% soil + 50% cowdung; T_{10} =50% soil + 50% cowdung + 75% RD; T_{11} = 50% soil + 50% cowdung + 50% RD. The pot size was10"x8" for single plant and BARI Tomato-14 was used as planting material. Days to 50% flowering varied from 51.50 to 58.40 days. The tallest plant (88.0cm) was observed from T_2 treatment followed by T_{11} and the shortest plant was from T_6 treatment. The highest cluster number (15.3) was recorded from T_{11} treatment followed by T_9 and T_{10}. The highest fruit number were recorded from T_2 treatment followed by T_9 and the lowest fruit no. was recorded from T_3, T_4, T_5 treatment and varied from 15.0-17.3. The highest identical average fruit wt. was recorded from T_{10} and T_{11} (70.0g) treatment and the lowest was recorded from T_4 (22.5g). Maximum fruit length and breadth were observed from T_2 (5.2cm and 3.8cm). The highest identical fruit yield (56.4, 59.5t/ha) was observed from T_{10} and T_{11}.

Effect of molybdenum and method of application on seed production of cauliflower

The experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2015-16 to find out the appropriate dose of Molybdenum for seed production of cauliflower (var. BARI Fhulcopi 1). Five Mo doses viz. 0 kg/ha , 0.5 kg/ha, 1.0 kg/ha , 1.5 kg/ha, 2.0 kg/ha, and three application method viz. 100% basal, 50% basal + 50% foliar spray and 100% foliar spray were used as treatment variables. The maximum number (16.33) of leaves/ plant was found in 2 kg Mo/ha as basal application which was statistically similar to 1.5 kg Mo/ha (16.00) as basal application and the minimum number (13.33) of leaves/plant. The earliest flowering (114 days) occurred at 0.5 kg Mo/ha used as 100% basal. The highest seed yield (240.71 kg/ha) was obtained from 1.5 kg Mo/ha used as 50% basal + 50% foliar spray which was statistically similar to 1.5 kg Mo/ha used as 100% basal. Significantly the lower seed yield (122.76 kg/ha) was obtained from control.

Protective cultivation

Development of micro garden model for medium size urban family through soilless culture

An experiment was conducted on micro garden for medium size urban family in non-circulating system of soilless at vegetable division, HRC, BARI, 2016.In micro garden model the Tomato per plant yield was 1.9 and 12 kg per plot. Capsicum 0.6 kg per plant and 2.4 kg per plot, lettuce per plant yield 0.25 kg, bitter gourd per plant 2.2 kg, green chilli per plant yield was 0.63, okra per plant yield 0.28, sweet potato per plant yield 0.27, red amaranth per unit area yield was 4.7 kg and Indian spinach yield per plant was 0.3 kg, strawberry per plant yield was 0.36 kg and brinjal per plant yield was 1.04 kg and mint leaf yield was 0.40 kg per plant.

Observational trial of netted melon production in hydroponics culture

Observation trial on production of netted melon was conducted with netted melon variety AYESA in non-circulating system of hydroponics culture at glass house of HRC, BARI during 2015-16. The production of netted melon on hydroponics culture, data were presented in the table 2. It is revealed that plant height of netted melon ranges from 185-225 cm. Days to 1st flowering rages from 43-51. Days to harvest varied from 85-90 days. No of fruits per plant was 1-3 fruit, the size of the fruit length varied from 11.2-17.4 and diameter was 10.5-15.2 cm. Individual fruit weight ranges from 462-1020 g. Yield per plant was 470-1350 g.

Effect of different level of Fe-EDTA in nutrient solution on the growth and Fe uptake in gimakalmi

Gimakalmi plants were grown in five different levels of Fe-EDTA to evaluate the influence on growth and Fe uptake. The experiment was conducted under glasshouse condition at hydroponic facility of Olericulture division, HRC, BARI, Gazipur during winter season of 2015-16. The experimental design was completely randomized block design with three replications. Gimakalmi were cultured in hydroponics using 50% Enshi nutrient solution with an electrical conductivity (EC) of 1.32 dS/m and pH of 6.93. The 50% standard Enshi nutrient solution with increased concentration of Fe in the form of Fe-EDTA added to 50% standard nutrient solution (Fe ×1) to prepare 2 times (Fe ×2), 3 times (Fe ×3), 4 times (Fe ×4), and 5 times (Fe ×5). Application of different levels of Fe-EDTA showed statistically significant influence on root length and shoot fresh weight while shoot length and root fresh weight was unaffected in Gimakalmi. Shoot fresh weight was not statistically decreased until 4 times concentration of Fe-EDTA but it was decreased greatly after 5 times concentration. Considering the influence of increased concentration of Fe-EDTA on growth parameters, we can use 50% standard Enshishoo nutrient solution with 4 times Ee-EDTA for producing Fe rich (data to be obtained) Gimakalmi leafy vegetable.

Effect of coco-dust and gravel substrate on the growth and yield strawberry in soilless hydroponics

Strawberry plants were grown in five different mixtures of coco-dust and gravel to compare their influence under glasshouse condition at hydroponic facility of Olericulture division, HRC, BARI, Gazipur during winter season of 2015-16. The experimental design was completely randomized block design with 10 replicated plant/pots. The plants were supplied with 25% Enshishoo nutrient solution in every alternative day. Strawberry plant grown in five different mixtures of coco-dust and gravel substrates showed significant influence on number of leaves and root length. Root growth was hampered in plants grown in sole gravel substrate indicate that it has less moisture holding capacity and unfavorable environment of root growth. Fruit weight per plant was much greater in 50:50 (59% and 64% greater than sole coco-dust and sole gravel substrate, respectively) compared to either of the coco-dust based substrate. The result reveal that growth, yield and yield attributes and also fruit qualities were significantly higher in plants grown in 50:50 (coco-dust: gravel) substrate compared to other mixtures of coco-dust and gravel substrate. Therefore, coco-dust with its 50% mixture with gravel would be comparable in producing strawberry under soilless hydroponics.

Hydroponic technology at urban area of Dhaka city

The experiment was conducted during winter 2015-2016 in grower's field at Dhaka. Four high value horticultural crops namely, capsicum, tomato, cucumber and lettuce were selected for growing in hydroponic culture. Capsicum plant height ranges from 52.6-65.8 cm. The number of fruits per plant varied from 8-14. Fruit length was 13.7-16.5 cm. Fruit diameter was ranges from 4.5-5.2 cm. The individual fruit weight ranges from 85.6-150.3 g. The capsicum yield/ plant ranged from 550.5-902 g. Lettuce plant height range from 35.9-41.1 cm. The number leaves per plant was 23-27. Leaf length was varied from 13.2-18.2 cm. Leaf breadth was varied from 6.3-9.9 cm. Leaf weight varied from 3.4-4.8 g and yield per plant range was 78.2-1248 g. Tomato plant height ranged from 168-195 cm. No. of fruit per plant varied from15-20. Fruit length was varied from 15-20 cm. Fruit breadth was varied from 5.2-6.1 cm. Fruit weight range from70-180 g and yield per plant range from 1.1-3.6 kg. Cucumber plant height range from 125-141 cm. No. of fruits per plant was 3-5. Fruit length was 10.2-12.5 cm and fruit breadth was 3.4-5.3 cm. The 3 crops (lettuce, capsicum and cucumber) showed higher fruit yield in plastic bucket on hydroponic culture.

Year round production of selected vegetable crops through hydroponic culture

The experiment was conducted at the plastic house of Olericulture division of the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the 2015-2016. The growing seasons are T_1=Oct.-Jan., T_2=Feb.-May and T_3=Jun-Sept. In cucumber there is no significant difference in plant height among the planting time. Minimum days to 1st female flowering in T_1 (52 days) and maximum in treatment T_3 (53). Days to 1st harvest were earlier in T_2 (61 days) treatment. No of fruit was higher in T_1 treatment (8). The maximum yield was obtained from T_1 (1.8 kg) treatment and minimum in T_3 (1.3 kg). Tomato minimum days to 50% flowering inT_3 (64.3 cm) maximum in treatment. T_1 (78.0 cm). Days to 1st harvest were earlier in T_2 treatment (73 days). No of fruit was higher in T_2 (25.0) treatment and lower in T_3 (21.0). The maximum yield was obtained from T_2 (2.8 kg) and minimum in T_3 (1.7 kg) respectively. Bitter gourd plant heights were higher in T_3 treatment (481.25 cm). Cucumber produced higher yield in treatment T_1 (Oct-Jan), while tomato and bitter gourd produced higher yield in T_2 (Feb-May) due to higher contributing characters.

Evaluation of mushroom varieties

An experiment was conducted at the Olericulure Division, HRC, BARI, Gazipur during the period from November 2015 to February 2016 to study the varietal performance of 5 oyster mushroom varieties. The yield performance of five mushroom varieties (*Pleurotus ostreatus, Pleurotus florida, Pleurotus sapidus, Pleurotus highking* 51 and *Pleurotus sajor-caju* (PSC)) showed significant vitiation. Among the varieties, *Pleusotus ostreatus* produced maximum effective fruiting body (43.00), biological yield (273.50 g) and marketable yield (264.50 g) followed by *Pleurotus highking* 51 (257.60g) and *Pleurotus florida* (240.50 g).

Breeder seed production

Breeder seed production of different released vegetable varieties

As part of national vegetable seed production programme, BARI is responsible for the production of breeder seeds of their own varieties. Breeder seed of BARI released varieties were produced at different RARS, RHRS and ARS under HRC, BARI along with Vegetable Division of head quarter. The total production and distribution of breeder seed during of winter 2015-16 was 1513 kg of targeting 2001.5 kg while in summer 2014-15 was 477.2 kg with a target of 792.0 kg. About 1621.5 kg breed seed was distribution to different organizations such as BADC, DAE, NGOs, Seed companies, universities, colleges, farmers homestead gardening, disaster affected areas, and seed fair programs during 2015-16.

Plant physiology

Effect of plant growth regulators on vegetative growth, sex expression and yield of summer bottle gourd cv. BARI lau 4

A field experiment on bottle gourd (*Lagenaria siceraria* Molina) taking the variety BARI Lau 4 was conducted at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during February 2015 to June 2016 to study the effect of plant growth regulators on growth, sex expression, yield and yield components of the crop. The experiment consisted of 8 growth regulator treatments viz., GA_3 10 ppm, GA_3 30 ppm, NAA 100 ppm, NAA 150 ppm, MH 50 ppm, MH 150 ppm and CCC 500 ppm along with distilled water considered as control. The results of the investigation indicated significant differences among the treatments on most of the parameters studied. All growth regulator treatments performed well in respect of all characters studied. MH 150 ppm and CCC 500 ppm performed well in respect of number of female flowers and number of fruits per plant, sex ratio, individual fruit weight, fruit weight per plant and yield per hectare as compared to control and other growth regulators. Application of 100 ppm NAA gave the lowest number of male flowers (81.67/plant) which was identical with 150 ppm MH (82/plant). MH 150 ppm gave the highest number of female flowers (37.33/plant) and the maximum number of fruits (12/plant). The experimental data revealed that the maximum fruit weight/plant anf fruit yield per hectare was recorded significantly with the application of MH @ 150 ppm (29.33 kg/plant and 97.62 t/ha)) closely followed by CCC @ 500 ppm (26.56 kg/plant and 88.52 t/ha) as compared to other treatments and the lowest yield was obtained in control. The increase in fruit yield was attributed due to increase in number of female flowers per plant and number of fruits per plant. Application of GA_3 @ 30 ppm gave the reasonable yield of bottle gourd.

Effect of application frequency of NAA on physio-morphological characters, yield and yield components of brinjal

A field experiment on brinjal (*Solanum melongena* L.) having six NAA (naphthalene acetic acid) application frequency treatments viz. distilled water spray (control) (T_0), spraying at 15 days interval after transplanting (T_1), spraying at 15 days interval after transplanting and at 1st flower initiation stage (T_2), spraying at 15 days interval after transplanting and then thrice spray at 15 days interval starting from 1st flower initiation stage (T_3), one spray before 7 days of first flower initiation and thrice spray at 7 days interval starting from 1st flower initiation stage (T_4) and one spray before 15 days of first flower initiation and thrice spray at 15 days interval starting from 1st flower initiation stage (T_5) at the field of plant physiology section of HRC during the rabi season of 2015-2016 to find out the suitable application frequency of NAA for higher and profitable yield of brinjal. The concentration of NAA was 40 ppm. The NAA application frequencies had no significant effect on plant height, number of leaves/plant, leaf area/plant and specificc leaf weight. The T_1 and T_4 treatments showed identical performances in respect of all parameters and T_1 treatment gave maximum chlorophyll content index (CCI), Fv/Fm (efficiency of photosystem II), total dry matter/plant, long and medium styled flower percent, fruit set percent, number of fruits per plant and fruit yield per hectare. Among the frequency treatments, T_4 treatment gave the maximum BCR of 4.39 followed by T_1 treatment (4.30).

Effect of GA_3 and NAA on growth and yield of cabbage

A field experiment was conducted at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during the *rabi* season of 2015-16 to study the response of cabbage cv. K. S. 1 to foliar application of PGRs namely GA_3 and NAA with different concentrations. The experiment was laid out in randomized complete block design. The experiment consisted of eight growth regulator treatments viz., three levels of GA_3 (50, 75 and 100 ppm) and four levels of NAA (40, 60, 80 and 100 ppm) along with distilled water considered as control. Foliar spray of GA_3 and NAA was given at 25 and 45 days after transplanting of cabbage seedling. The results of the investigation indicated significant differences among the treatments on most of the parameters studied. Application of GA_3 50 ppm and NAA 60 ppm increased plant height, plant spread, number of leaves, chlorophyll content, quantum yield of Photosystem II (Fv/Fm), head height, head diameter, single head weight without unfolded leaves as well as head yield (81.18 t/ha and 78.57 t/ha) than the control (67.29 t/ha) and other treatments. Application of GA_3 50 ppm and NAA 60 ppm increased the head yield 20.64% and 16.76%, respectively over control.

Effect of GA_3 on seed yield and yield attributes of broccoli cv. BARI broccoli 1

A field experiment on broccoli cv. BARI Broccoli-1 having six concentrations of GA_3 (gibberellic acid) viz. 0, 20, 40, 60, 80 and 100 ppm was carried out during the *rabi* season of 20154-2016 at the field of plant physiology section of HRC. Twenty five day- old seedlings were treated before transplanting by dipping their roots for 24 h in different concentration of GA_3. The GA_3 significantly influenced the growth performance, head and seed yield attributes of broccoli. GA_3 60 ppm gave maximum growth, head yield and seed yield attributes as well as seed yield of broccoli. Application of GA_3 60 ppm produced the maximum seed yield (565.3 kg/ha) which was identical with GA_3 40 ppm (541.6 kg/ha).

Screening of sweet gourd germplasm against salinity at germination and early seedling growth stages

Forty five sweet gourd genotypes were tested against 8 dS/m salinity level with control in petri dish at the Plant Physiology laboratory of HRC, BARI, Gazipur during 2015-2016 to find out the salt tolerant genotypes at germination and seedling growth stages. Distilled water (0 ds/m) was used as a control. Germination percentage, seedling root and shoot length, root and shoot dry weight and seed vigour were found to be affected by salinity level. The genotypes BD10149, BD10134, BD4383, BD4382, BD4371, BD4370, BD4368, BD4357, BD4343 and BARI Mistikumra-1showed better performance at 8 dS/m in respect of relative germination rate, relative percentage of shoot and root length, relative percentage of root and shoot dry weight and seed vigour index.

Screening of spinach germplasm against salinity during germination and early seedling growth stage

Twenty one spinach genotypes were tested against 8 dS/m level of salinity in petri dish at the Plant Physiology laboratory of HRC, BARI, Gazipur during 2015-2016 to find out the salt tolerant genotypes at germination and seedling stages. Distilled water (0 ds/m) was used as a control. Germination percentage, relative germination rate, relative percentage of shoot and root length, relative percentage of root and shoot dry weight and seed vigour were found to be affected by salinity levels. The genotypes BD-9665, BD-4340, BD-4323, BD-4335, BD-4333, BD-4337, BD-10602, BD-4324 and BARI Spnich-1 showed better performance in respect of germination percentage, relative germination percent seed vigour at 8 ds/m.

Disease control

Screening of eggplant germplasm against bacterial wilt

Seventeen eggplant accessions were screened for resistance to *Ralstonia solanacearum* grown under artificial epiphytotic conditions during 2015-2016 cropping seasons. Four lines such as SM083A, SM83C, SM217 and SM204A gave resistant reaction under field condition in Gazipur. Eleven accessions of eggplant showed moderately resistant reaction. Two lines showed moderately susceptible reaction to *R. solanacearum*. The moderately resistant lines will be tested for further evaluation.

Screening of tomato germplasm against bacterial wilt

Thirteen tomato accessions were screened to find out bacterial wilt resistant source grown under artificial epiphytotic field conditions during 2015-2016 cropping seasons. Two accessions namely STM-09 and STM-003 gave resistant reaction under Gazipur conditions. Eight accessions of tomato were showed moderately resistant reaction, three lines moderately susceptible to *R. solanacearum*. The moderately resistant lines will be tested for further evaluation.

Screening of eggplant germplasm against root-knot nematode

Seventeen eggplant varieties/lines were tested in a nematode infested sick bed for their resistance to root-knot nematode. Among them three lines (SM 048, SM 217 and SM 258) were found resistant, eight lines moderately resistant, three lines moderately susceptible and three lines susceptible to root knot nematode.

Screening of tomato germplasm against root-knot nematode

Thirteen tomato varieties/lines were tested in a nematode infested sick bed for their resistance to root-knot nematode. Among them, two lines showed resistant, three lines showed moderately resistant reaction, three moderately susceptible and four lines susceptible to root knot nematode.

Screening of tomato germplasm against tomato yellow leaf curl virus disease

An experiment was conducted at plant pathology Section, HRC, BARI during winter 2015-16 cropping season with some promising variety and lines of tomato to find out resistant sources against Tomato Yellow Leaf Curl Virus disease. A total of ten tomato variety/ lines were evaluated. Among them, only one line (SL0011) was recorded as highly resistant (HR) to TYLCV disease. Four variety/ lines (SL 0012, BARI Tomato 15, BARI Tomato 11 and GWT 0062) were resistant (R) and four (GWT 0052, BARI Tomato 3, GBT 0037 and BARI Tomato 2) were moderately resistant (MR) to the disease. Only BARI Tomato 8 (susceptible check) was moderately susceptible (MS) to TYLCV. Higher yield was obtained by SL 0011 (960 g/plant), BARI Tomato 15 and GWT 0052 (880 g/plant). Disease incidence was positively correlated with whitefly population. Considering both disease and yield SL 0012 and BARI Tomato 15 may recommend the best line and variety, respectively.

Survey and monitoring on white mold disease of country in different areas of Bangladesh

White mold caused by *Sclerotinia sclerotiorum* is a major disease of bean crops. The pathogen is a necrotrophic and non-host-specific fungal pathogen that infects more than 400 species of plants (Boland and Hall 1994, Purdy 1979). In Bangladesh, *S. sclerotiorum* was first recorded on mustard in 2008 (Hossain *et al.,* 2008), then on chilli, auber-gine, and cabbage (Dey *et al.,* 2008). Recently the disease is attacking almost all the vegetables, flowers (Mary-gourd, gerbera) and fruit crops (jackfruit). It also attacks oil seed crops. Bogra area was found more disease prevalence areas. However, more survey is necessary to collect isolates from different areas of Bangladesh.

Management of TYLCV through chemical and cultural means

An experiment was conducted at plant pathology Section, HRC, BARI during winter 2015-16 cropping season to select a suitable management practice against tomato yellow leaf curl virus disease.

BARI tomato-8 variety was used in the experiment. Five treatments like yellow plastic mulch, straw mulch, barrier crops, neem seed extract and control (Admaire) were evaluated against TYLCV disease of tomato. All the treatments significantly reduced disease incidence over the control. Higher disease incidence was recorded in control plots whereas it was the lower in yellow plastic mulch and in straw mulch plots in both of the years. In 2015 higher yield was harvested from straw mulch and moderate yield from yellow polyethylene mulch. While in 2016, the maximum yield was recorded in yellow polyethylene mulch followed by straw mulch. The lowest yield was recorded in control plot. Among the four treatments, yellow plastic mulch and straw mulch were effective to control whitefly population and reduce TYLCV disease incidence in tomato field.

Standardization of talc base formulation of *Trichoderma viride* for disease management of cabbage

The experiment was conducted with cabbage (variety Atlas 70) to standardize the talc based formulation of *Trichoderma viride* and maize bran mixing ratio before application to control soil borne pathogens. Five ration of talc Trichoderma: maize bran (1:2, 1:3, 1:4, 1:5 and 1:6) were tested. Control was maintained without any Trichoderma application. All Trichoderma treatment reduced disease incidence. The highest disease incidence was recorded in control treatment. Talc *Trichoderma* and maize bran ratio 1:4 and 1:5 reduced the maximum disease incidence (77.83%) over control. Length, diameter and biomass of cabbage were not influenced by talc Trichoderma application. However, head weight and marketable yield affected due to talc Trichoderma application. Single head weight was higher in 1:5, 1:4 and 1:3 mixing ratio of talc Trichoderma and maize bran. Yield increased over control was 22% in 1:5 ratio of talc Trichoderma and maize bran mixing treatment followed by 17.25% in 1:4 and 15.94% in 1:3 ratio. Considering disease incidence and yield 1:5 ratio of talc Trichoderma and maize bran mixing may recommend for soil application.

Use of Tricho-products for soil borne disease management of vegetable crops at farmers' level

Tricho-compost and Tricho-leachate reduced diseases incidence and increased yield in vegetable crops. In project site, pointed gourd and brinjal were cultivated. Application of two Tricho-products reduced diseases and increased yield in vegetable crops. Fruit rotten caused by fruit fly and *Phytophthora* sp were lower in Tricho-compost plot compared to control plot in pointed gourd field. Fruit rot in pointed gourd was 2.96% in Tricho-compost plot and 5.67% in farmers' practices at Bogra, while it was 2.45% in compost and 5.03% in farmers' practices at Jessore. Fruit rotten of pointed gourd was reduced by 37.78% and 34.79% in Jessore and Bogra, respectively in compost field. Soil application of Tricho-compost reduced bacterial wilt in brinjal crop. Bacterial wilt of brinjal was reduced by 73.39% and 67.83% in Jessore and Bogra, respectively in Tricho-compost treated soil. Fruit damaged due to insect and pathogens were 11.95% in Tricho-compost plot and 23.0% in farmers' practices at Jessore, while it was 6.26% in compost and 11.1% in control plot at Bogra project site. Total and marketable yield of pointed gourd increased in Tricho-compost treatment in both project sites. Marketable yield was increased by 20.74% and 25.22% in Jessore and Bogra, respectively in Tricho-compost treatment. Total and marketable yield of brinjal also increased in Tricho-products application field compared to control field. Yield increased over control was 27.01% and 21.27% in Jessore and Bogra, respectively. Benefit Cost Ration increased over control was 18.91% and 21.40% in Jessore and Bogra, respectively in pointed gourd. Similarly in brinjal it increased 29.23% and 23.69% in compost field at Jessore and Bogra, respectively.

Up-scaling of Tricho-compost production technology at farmers' level

The experiment was conducted for up-scaling of Tricho-compost production technology at farmers' level. Ten farm families from each of Jessore and Bogra were involved in Tricho-compost preparation since 2014. Now a days, the farm family involvement increased in double in Bogra site project site. In Jessore project site four more family increased along with ten farm family. Both cementing ring made house and brick made house were used for Tricho-compost production. The capacity of raw material loading for one pair cement ring house and a single brick made house were about 420 kilogram and 840 kilogram, respectively. Measures amount of poultry refuse, cowdung, vegetable waste/ kitchen waste, processed water hyacinth, mushroom waste/ sawdust, molasses and *T. harzianum* were used as raw materials of the compost. A total of 36.96 ton Tricho-compost and 1070 liter Tricho-leachate were produced was produced from four loading from Jessore and Bogra during June 2014 to May 2015. Production technology was well accepted by farmers and neighbor farmers' started to produce Tricho-compost.

Pest control

Relative susceptibility of six country bean variety against aphids and pod borer

A study was carried out at Entomology section Research Field of Horticultural Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi 2015-16 cropping season to check the relative susceptibility of BARI released country bean varieties to aphid and pod borer. Six BARI released country bean varieties viz., BARI Sheem 1, BARI Sheem 2, BARI Sheem 3, BARI Sheem 4, BARI Sheem 6 and BARI Sheem 7were included in this study in a randomized complete block design with three replication. Different BARI released country bean varieties showed variation in susceptibility grade to aphid and pod borer. It is evident from the results that no variety was found tolerant against aphid and pod borer. But BARI Sheem 6 and BARI Sheem 7 showed moderately susceptible and BARI Sheem 1 showed susceptible and BARI Sheem 2, BARI Sheem 3 and BARI Sheem 4 showed very susceptibility to aphid. In case of pod borer infestation BARI Sheem 7 ranked as moderately tolerant. BARI Sheem 3(0.44 larvae/pod) and BARI Sheem 4 (0.81 larvae/pod) ranked as moderately susceptible. BARI Sheem 1 (1.67 larvae/pod) and BARI Sheem 6 (1.31 larvae/pod) ranked as susceptible in the present study. Similar susceptibility grading was also observed in case of percentage of pod borer infestation. The highest marketable yield was found in BARI Sheem 1 (12.53t/ha).

Relative susceptibility of BARI released tomato varieties to fruit borer, leaf miner and whitefly

The study was carried out at Entomology section Research Field of Horticultural Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi 2015-16 cropping season to check the relative susceptibility of BARI released tomato varieties to fruit borer, leaf miner and whitefly infestation. A total of eight BARI released tomato varieties were included following RCB designed with four replications. Results showed that no varieties were found tolerant against these pests. The leaf miner infestation ranged from 26.40% to36.88%. Fruit borer infestation was minimum in each varieties ranged from 0.60% to 3.97% but the relative abundance of whitefly population varied significantly and the lowest population of whitefly received from BARI tomato11 and the highest in BARI tomato 8. Again BARI tomato 14, BARI tomato 16 and BARI tomato 17 showed less susceptibility against virus disease. BARI tomato 17 gave the highest marketable yield as compared to other varieties.

Soil and water management

Effect of boron and molybdenum with USG on the yield and quality of cauliflower

The study was conducted at the experimental field of Horticulture Research Centre, BARI, Gazipur during *rabi* season of 2014 -2015 to 2015 -2016 to evaluate the efficiency of USG in combination with or without B and M_o on cauliflower production to evaluate the response of cauliflower to micronutrients on quality cauliflower production and to develop an USG based optimum and economic dose of fertilizer recommendation for quality cauliflower production. The experiment was conducted in RCB design with 3 replications and nine treatments were considered with different levels of USG with and without B and Mo. Higher yield was resulted where B and Mo were used than in recommended USG without these micronutrients. The maximum curd yield (30.494 and 37.900 ton ha^{-1}) was found in T_4 treatment followed by T_1 (30.247 and 37.650 ton ha^{-1}) in 2014 -2015 and 2015 -2016, respectively. In the economic point of view it was also observed that T_4 (85 % recommended dose of N as USG: $N_{119}B_1Mo_{0.8}$ (N as USG)) is the most profitable dose with the highest BCR (4.25 and 5.28) for the year 2014-15 and 2015-16, respectively.

Effect of USG and Boron application on the yield and quality of summer tomato

The experiment was conducted in the field of HRC, BARI during summer 2015 in by RCBD with three replication. Six treatments were considered as- i) Recommended dose with N as USG: $N_{140}B_2$ (N as USG ii)Recommended dose with N as USG – B: $N_{140}B_0$ (N as USG; iii) 85 % recommended dose with N as USG: $N_{125}B_2$ (N as USG); iv) 85 % recommended dose with N as USG – B: $N_{125}B_0$ (N as USG); v) 70 % recommended dose with N as USG: $N_{105}B_2$ (N as USG) and vi) 70 % recommended dose with N as USG – B: $N_{105}B_0$ (N as USG). It revealed from the study that USG and B application has some economic benefit for summer tomato production and 85% recommended USG and 2 kg B/ha is the most productive and economic dose for summer tomato production.

Study of USG and prilled urea in relation to nitrogen supply and its effect on the growth and vine production of bottle gourd

An experiment was conducted during *rabi* season 2015-16 at HRC, BARI to find out the duration of N supply, its behavior and N use efficiency of plant from USG and PU and to study the growth patterns of the crop influenced by the USG and PU. The experiment was conducted followed by CRD with 3 replications. Five treatments were selected as T_1= without fertilizer (Native fertility); T_2= Recommended prilled urea (PU); T_3= Recommended urea super granule (USG); T_4=85% of recommended urea super granule (USG); T_5=70% of recommended urea super granule (USG). Nitrogen behavior and its effect on crop growth with USG and PU were significantly affected and USG produced higher plant height, leaves/plant, fresh shoot and root weight as well as dry shoot and root weight in later stages of crop development although these were higher with PU in the initial growth stage. Maximum fresh shoot yield (1224 g) was found in recommended USG (T_3) followed by 85% recommended USG (T_4, 1200 g). Higher branch/plant, flower/plant and SPAD value were also found from USG treated plants than PU which indicated that USG supply N for a longer period of time than prilled urea for higher N uptake and plant growth.

Evaluation of urea super granule (USG) technology for upland vegetables at different locations of Bangladesh

The experiment was conducted on cabbage (var. Atlas 70), cauliflower (Hybrid F_1- Sirajico) and broccoli (Premium crop) in the location HRC, BARI, Joydebpur only in 2015-16 cropping season followed by RCB design with 3 replication to popularize and adoption of the USG technology by the vegetable growers, to reduce cost of production through minimum use of urea fertilizer and to improve vegetable production and farmer's income. Two treatments were selected as T_1= Prilled urea (PU) and T_2= Urea super granule (USG). From one year results it was observed that USG is more profitable than PU both in respect of yield and economic profitability for cabbage, cauliflower and broccoli production.

Effect of potassium in increasing the shelf life and quality of tomato through IPNS approach

The present study was undertaken to find out the effect of K on the shelf life of tomato, to know the effect of organic and inorganic combinations of K in increasing yield and shelf life of tomato and to observe the use efficiency of vermicompost and cowdung. The experiment was conducted at the experimental field of HRC, BARI, joydebpur during *rabi* season, 2015-2016. The basic dose of K was estimated from soil test basis depending on the present recommendation. The K dose further increased by 125% to 175% of the STB dose. The required amount of K as per treatment was supplied from 25% from organic fertilizer (vermicompost and cowdung) and 75% from chemical fertilizer (muriate of potash.) following IPNS approach. In addition to 100% STB dose from chemical fertilizer. cowdung and Vermicompost. The tested variety was BARI Tomato-14. Tomato was harvested at pink stage from plant. T_4 gave the highest number of fruit weight per plot (37.20 kg) and yield (51.67 tha^{-1}). T_{10} gave the lowest effect on physiological weight loss (22.11%) and the highest marketable fruit

(86.13%) at 15^{th} day of storage. T_5 gave the lowest effect on physiological weight loss (55.48%) and T_6 gave the highest marketable fruit (51.11%) at 30th day of storage. In case of economic analysis T_4 gave the second highest (3.67) Marginal Cost Benefit Ratio (MBCR). Vermicompost showed more efficiency than conventional compost and inorganic fertilizer regarding tomato cultivation and shelf life of tomato. Treatment $T_{10,}$ which is Vermicompost at the rate of 2.80 tha^{-1} with 75% of recommended chemical fertilizers (N_{140} P_{16} K_{38} S_6kg ha^{-1}) following IPNS approach, is recommended for tomato cultivation in HRC, BARI, joydebpur, Gazipur.

Development of USG based fertilizer recommendation for bitter gourd

An experiment was conducted at HRC, BARI, Joydebpur during 2014 to 2016 on bitter gourd to ascertain the comparative performance of USG and prilled urea in relation to yield and economics and to develop an USG based fertilizer recommendation for bitter gourd. The experiment was conducted in RCB design with three replications and six treatments were as i) Recommended dose of N as PU: N_{120} (N as PU) ii) Recommended dose of N as PU: N_{120} (N as USG) iii) 85% recommended dose of N as USG: N_{102} (N as USG) iv) 70% recommended dose of N as USG: N_{84} (N as USG) v) 55% recommended dose of N as USG: N_{66} (N as USG) and vi) Native fertility. From three years study, results showed that performance of USG is much better in relation to normal prilled urea in bitter gourd production and the treatment T_4 produced the maximum bitter gourd yield (20.40, 21.119 and 19.71 t/ha) with maximum gross return of Tk. 408000, 422380 and 394200 /ha, respectively for the years 2014, 2015 and 2016 and maximum MBCR also found from T_4 treatment. Treatment T_3 also showed the satisfactory yield and economic benefit. Therefore treatment T_4 i.e. 70% recommended dose of N as USG: N_{84} (N as USG) followed by 85% recommended dose of N as USG: N_{102} (N as USG) could be suggested for better yield and production of bitter gourd.

Effect of vermincompost and cowdung on the yield of cucumber

An experiment was conducted at HRC, BARI, Joydebpur during 2014 to2016 on cucumber to study the efficiency of vermicompost and cowdung along with chemical fertilizer on cucumber production and to determine the nutrient uptake as influenced by vermicompost along with chemical fertilizer. The experiment was conducted in RCB design with six treatments as T_1: control; T_2: CF (100%); T_3: CD (5 t/ha) +CF (IPNS-based on N); T_4: VC (4 t/ha) + CF (IPNS- based on N); T_5: CF (100%) + CD (5 t/ha) and T_6: CF (100%) + VC (4 t/ha). From three years result it was found that the treatment T_4 produced the better cucumber yield (28.39 t/ha) with maximum gross return of Tk. 425850/ha. But treatment T_3 showed the most economically profitable dose in terms of MBCR (6.03).

Effect of NPKS on the growth and yield of broccoli at hill valley

A field experiment comprising fourteen fertilizer treatment viz., $T_1 = N_0P_0K_0S_0$, $T_2 = N_0 P_{50}K_{80}S_{24}$, $T_3 = N_{70}P_{50}K_{80}S_{24,}$ $T_4 = N_{140}P_{50}K_{80}S_{24}$ (FRG, 2012), $T_5 = N_{210}P_{50}K_{80}S_{24,}$ $T_6 = N_{140}P_0K_{80}S_{24,}$ $T_7 = N_{140}P_{25}K_{80}S_{24,}$ $T_8 = N_{140}P_{75}K_{80}S_{24}$, $T_9 = N_{140}P_{50}K_0S_{24,}$ $T_{10} = N_{140}P_{50}K_{40}S_{24}$, $T_{11} = N_{140}P_{50}K_{120}S_{24}$, $T_{12} = N_{140}P_{50}K_{80}S_0$, $T_{13} = N_{140}P_{50}K_{80}S_{12}$, and $T_{14} = N_{140}P_{50}K_{80}S_{36}$ was conducted at the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati Hill district during 2015-16 to find out the appropriate dose of fertilizer for better growth and yield of broccoli in hill valley of Chittagong Hill Tracts. The highest yield (12.3 t/ha) was observed in T_5 treatment followed by T_8 (11.0 t/ha) and lowest (2.6 t/ha) in control treatment followed by T_6. In both the low yielded treatment phosphorus was nil.

Post harvest management

Observation of different combination of ready-to-cook mixed vegetables

The experiment was conducted at the laboratory of Postharvest Technology Section, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during March 2016 to select suitable additives for preparing ready-to-cook mixed vegetables. Mixed vegetables were treated with T_1= 0.5% ascorbic acid, T_2= 0.5% citric acid and T_3= 0.5% $CaCl_2$ and stored at refrigerator (4±1°C). Ready-to-cook mixed vegetables treated with 0.5% citric acid (T_2) showed better shelf life 7 days over all treatments retaining better color, total acidity (%), vitamin C and sensory quality stored at refrigerator (4±1°C).

Effect of food additives on ready-to-cook pumpkin

The experiment was conducted at the laboratory of Postharvest Technology Section, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during April 2016 to select suitable additives for preparing ready to cook pumpkin. Ready-to-cook pumpkin slices were treated with T_1= 0.1% Ascorbic Acid, T_2= 0.1% Citric Acid, T_3= 0.1% Calcium Chloride ($CaCl_2$) and stored at refrigerator (4±1°C). Pumpkin treated without any additives (T_4) showed better shelf life 10 days over all treatments retaining better color, total acidity (%), vitamin C and sensory quality stored at refrigerator (4±1°C). Treatment T_4 (control) showed the second highest value (0.21%) in total acidity, slow decrease rate in ß-carotene (0.35 to 0.10 mg/g) and the highest score in sensory properties till the end of storage day (10 days) at refrigerator (4±1°C).

Effect of edible coating on postharvest quality of bell pepper

Bell pepper (*Capsicum annuum* L.) was coated either with chitosan (1.5% and 2% solution) or Aloe vera (AV) gel and coating was air dried. Coated peppers were kept into paper cartoon and stored in ambient condition (25±2°C and 55±5% RH). The success of coating in retaining postharvest quality of bell pepper was evaluated by determining respiration rate, ethylene production, firmness, weight loss, external colour change, ß-carotene content, ascorbic acid content, TSS, P^H, fungal decay and sensory quality. The incidence of rot started on 6^{th} day in uncoated bell pepper. Fruits coated with 1.5% and 2% chitosan affected by microbial decay on 9^{th} day of storage. On the other hand, rot incidence was initiated in 2% chitosan and AV gel coated bell pepper on 12^{th} day of storage. AV gel or chitosan coating reduced respiration rate, weight loss, decay and preserved colours, firmness, ascorbic acid content and other quality parameters thus delaying the progress of fruit decay due to senescence or microbial attack.

Handling trials of brinjal to evaluate the technical and economic feasibility of improved postharvest management system

A study was carried out to determine the suitability and effectiveness of developed postharvest technologies and best practice in improving brinjal value chains in Bangladesh. A popular and commercially grown brinjal cultivar in Jessore namely ‘Chaga’ was used in this study. Brinjals were directly purchased from the growers at a local market of Jessore. The traditional postharvest practice consisted of using bamboo baskets as collecting containers, no sorting, grading and washing, and packing brinjals in 100 kg jute sacks for transporting to the long distance wholesale market. On the other hand, sorting, grading, washing were done for improved practices and packed in plastic crate with or without MAP to compare with existing practices for physical damages and losses occurred at wholesale and retail levels. The use of plastic crate with MAP packaging reduced weight losses by 26.7 and 38% at wholesale and 2-days retail display. During wholesale and 2-day retail period, there was higher recovery of sound (no damage) brinjals in plastic crates than the jute sacks. The average reduction in mechanical damage with the use of plastic crate with MAP amounted to 79.5% and 100% reduction in losses upon arrival in the wholesale market and 2-day retail period. Thus, the use of plastic crate with MAP as packaging container during long distance transportation of fresh brinjal is more effective and economically feasible technology in reducing postharvest loss and in getting more market price of the produce.

Non-destructive quality assessment of summer tomato using differential absorbance meter

The differential absorbance meter (DA Meter), an innovative, non-destructive instrument for determining fruit maturity by measuring chlorophyll content in the skin is a portable spectrometer, which was claimed to monitor on-tree fruit ripening to accurately establish optimal harvest maturity. This research was conducted to examine the applicability of DA Meter in the rapid, non-invasive assessment of quality parameters using BARI Tomato-8, a commercial tomato variety grown in summer season at the research field of Horticulture Research Centre, Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh. Flowers were tagged on first day of fruit set to determine the stage of fruit development. Tomatoes were harvested at alternate day started on 21 days after fruit set (DAFS) until 31 DAFS. At each sampling period, difference in absorbance index (DAI), fruit firmness, colour readings and other quality attributes were measured on of 20 fruit, replicated 3 times (total of 60 fruit). Correlation analysis was performed on the means of each replicate to determine if there was a relationship between DAI and other fruit maturity indicators. The highest DAI, which indicated the chlorophyll contents of tomato was recorded 1.05 at premature green stage, declined gradually and became zero in light red and red ripe tomatoes. The values of lightness, hue angle, firmness, pH and chlorophyll contents were also higher in premature green tomatoes and were gradually decreased with lengthening the harvesting time and the lower values were found in red ripe tomatoes harvested at 31 DAFS. The changes of ascorbic acid and TSS of tomato did not follow the linear model during fruit development. During harvest, strong correlation coefficients were obtained between the DA meter readings with hue angle, chlorophyll contents, titratable acidity and firmness of tomatoes showing r values of 0.93, 0.91, 0.91 and 0.92-0.94, respectively. The low correlation was noted with lightness of skin colour, pH and ascorbic acid contents compared to hue angle or flesh firmness. Results of the present study indicated that maturity stages, flesh firmness, TA and skin colour were significantly influenced by evolvement of chlorophyll index and DA Meter has the potential in measuring most quality parameters non-destructively in tomato.

Integrating non-chlorine sanitizing, precooling and modified atmosphere packaging in low-cost cooling systems for brinjal

This study combined the use of non-chlorine sanitizer, precooling and modified atmosphere packaging (MAP) as pre-storage treatments for brinjal kept in simple evaporative cooler (EC) or coolbot cold storage (CS). Precooling was done by dipping the fruit in 10 °C water. As non-chlorine sanitizing treatment, dipping fruit in 0.01% calcinated calcium (CCa) solution for five minutes at ambient temperature was used. For a combined precooling and sanitizing treatment, 10 °C CCa solution was used. Fruit dipping in normal tap water served as the control. After air-drying of surface, fruit were packed in 30 µ-thick polyethylene bags with 0.5% perforation as MAP medium; fruit held in the open and storage at ambient served as control. Fruit were then stored in the EC or CS. The commercial brinjal variety was used at 5 kg per replication. EC temperatures (24.3-27.5 °C) were consistently lower and less fluctuating than ambient temperatures (27.8-31.0 °C). Coolbot temperature was maintained at 13±1°C. Relative humidity (RH) was showing about 75±2 % in CS, whereas it was 75-95% at ambient and 85-99% in EC. Fruit in the CS lasted for 14 days when packed in MAP. Rotting affected >50% of the fruit on day 5 of ambient storage and of EC. In the CS, fruit rotting was first noted on day 9, increased gradually and reached 30 to 60% on day 15. Sanitizing treatment using 0.01% calcinated calcium showed significant effect in reducing the rot incidence up to a week but after that no effect was observed. On the other hand, MAP significantly reduced losses in weight, firmness and shriveling in CS condition. Vitamin C content was effectively maintained in the CS and was about 7.5 mg $100g^{-1}$ after 14 days of storage. EC and ambient stored fruit had similar vitamin C contents at day 4 of their storage life.

Effect of maturity stages on physicochemical characteristics and postharvest quality of tomato var. BARI tomato 14

A study was done to investigate the effect of maturity stages on physico-chemical characteristics and postharvest quality of tomato. The experiment was conducted at Horticulture Research Centre (HRC) of Bangladesh Agriculture Research Institute (BARI) during October 2015 to March 2016. Tomato var. BARI Tomato-14 was used in this trial. The plants were grown in the field with recommended production practices and fruits were harvested at different maturity stages to done sensory evaluation and analyses of physico-chemical characteristics and storage attributes. There were no wide differences in fruit weight and size among mature green, breaker-turning, pink and red stage harvested fruits. All the locules of the fruits of mentioned stages were found to be filled up by characteristic gel except immature and premature green fruits. The hue angle of harvested red stage fruits of BARI

Tomato-14 tomato was 59.62 and that of mature green, breaker-turning and pink stage harvested tomato was 120.26^0, 109.8^0 and 69.91, respectively. It decreased to 83.8^0, 56.3^0 and 52.24^0) in the above fruits after 8 days of harvesting and became nearer to red stage harvested fruits (51.16^0). The highest DA index (1.69) was recorded from pre-mature green harvested fruits and that of red stage fruits was zero. It decreased in all stages with storage time and became zero after some days. It decreased in all stages with storage time and became zero after some days. But it did not get to zero in immature green fruits. The firmness was recorded high in immature, premature and mature green stage tomatoes. Premature and mature green tomatoes were found to be ripened but immature green tomatoes did not ripen in the storage period. The highest vitamin C content was recorded from mature green harvested tomatoes (14.16 mg/100g). ß-Carotene content in fresh tomatoes was recorded high from pink stage harvested tomatoes (2.02 mg/100g) followed by red stage harvested tomatoes (1.82 mg/100g). Without taking into consideration the ripeness quality but retention of acceptable physical appearance, the highest shelf life (12.67 days) was calculated from mature green fruits followed by premature and breaker-turning stage harvested fruits (10.67 and 8.67 days, respectively). The red stage tomatoes could be selected for local consumption. Breaker-turning stage fruits should be harvested for distant marketing and mature green tomatoes could be harvested for subjected to artificial ripening to get uniform ripened fruits.

Effect of maturity stages on physicochemical characteristics and postharvest quality of tomato var. BARI tomato 15

A study was done to investigate the effect of maturity stages on physico-chemical characteristics and postharvest quality of tomato. The experiment was conducted at Horticulture Research Centre (HRC) of Bangladesh Agriculture Research Institute (BARI) during October 2015 to March 2016. Tomato var. BARI Tomato-15 was used in this trial. The plants were grown in the field with recommended production practices and fruits were harvested at different maturity stages to done sensory evaluation and analyses of physico-chemical characteristics and storage attributes. There were no wide differences in fruit weight and size among mature green, breaker-turning, pink and red stage harvested fruits. All the locules of the fruits of mentioned stages were found to be filled up by characteristic gel except immature and premature green fruits. The hue angle of harvested red stage tomato was 60.78^0 and that of mature green, breaker-turning and pink stage harvested tomato was 119.41^0, 118.04^0 and 82.82^0, respectively. It decreased to 57.28^0, 54.78^0 and 50.76 ^{0}in the above fruits after 8 days of harvesting and became close to red stage harvested fruits. The highest DA index (1.5) was recorded from pre-mature green harvested fruits and that of red stage fruits was zero. It decreased in all stages with storage time and became zero after some days. But it did not get to zero in immature green fruits. The firmness was recorded high in immature, premature and mature green stage tomatoes. Premature and mature green tomatoes were found to be ripened but immature green tomatoes did not ripen in the storage period. There was a little bit difference in TSS(%), total sugar (%), Vitamin C and β carotene content in the fruits of mature green, breaker-turning, pink and red stage harvested tomatoes. The weight loss and withering incidence was high in immature green fruits. But shriveling and decay incidence was high in red stage harvested tomatoes. Without taking into consideration the ripeness quality but retention of acceptable physical appearance, the highest shelf life (14.33 days) was calculated from mature green fruits followed by premature and breaker-turning stage harvested fruits (11.67 and 10.33 days, respectively). The red stage tomatoes could be selected for local consumption. Breaker-turning stage fruits should be harvested for distant marketing and mature green tomatoes could be harvested for subjected to artificial ripening to get uniform ripened fruits.

7 FRUIT CROPS

Varietal Development

Evaluation of jackfruit germplasm

Fifteen jackfruit germplasm i.e. AH Joy-028, AH Joy-029, AH Joy-031, AH Joy-036, AH Joy-055, AH Joy-059, AH Joy-063, AH Joy-065, AH Joy-068, AH Joy-069, AH Joy-070, AH Joy-074, AH Joy-075, AH Joy-076, AH Joy-078 were studied in the Fruit Research Farm of HRC, BARI, Gazipur. Wide range of diversity was observed in plant height, trunk height, plant spread, number of fruits per plant, fruit and pulp characters of jackfruit. Plant height varied from 4.40 m to 7.20 m, whereas trunk height ranged from 1.5 m to 1.90 m. Great variation in number of fruit (8 to 22) was also observed. Fruit characteristics of jackfruit germplasm also varied largely. The fruit weight ranged from 3.50 kg to 13.40 kg. Number of bulb per fruit varied from 67 to 275. TSS was noticed to vary from 17.8 to 23.0 ^{o}Brix. In respect of number of fruits, fruit weight, edible portion, TSS and pulp quality, the germplasm AH Joy-075 and AH Joy-070 were found promising. The experiment will be continued for further evaluation.

Collection and evaluation of jackfruit germplasm

The study was performed at the Regional Agricultural Research Station, Jamalpur. Twenty three jackfruit germplasm viz. AH Jam-01, AH Jam-02, AH Jam-03, AH Jam-04, AH Jam-05, AH Jam-06, AH Jam-07, AH Jam-08, AH Jam-09, AH Jam-10, AH Jam-11, AH Jam-12, AH Jam-13, AH Jam-14, AH Jam-15, AH Jam-16, AH Jam-17, AH Jam-18, AH Jam-19, AH Jam-20, AH Jam-21, AH Jam-22 and AH Jam-23 were selected to identify superior ones. A wide variability was observed in different parameters such as weight of individual fruit, number of fruits per tree, size of fruit, shape of fruit, number of bulbs or flake in a fruit, percent edible portion and percent TSS among the germplasm studied. The highest number of fruits (60) per plant was observed in AH Jam-02 and AH Jam-03 and the lowest (02) number of fruits was noted in AH Jam-07 and AH Jam-13. Maximum TSS was obtained in AH Jam-03 and AH Jam-21 (23 %) and minimum in AH Jam-09 (13%). The highest edible portion (60.74%) was obtained from AH Jam-02 and the lowest (18.39%) value was obtained from AH Jam-01. On the basis of fruit characteristics *i.e.* taste, sweetness, hardness of bulb, bulb color, fruit size, TSS, edible portion and yield, fourteen jackfruit germplasm (AH Jam-02, AH Jam-03, AH Jam-04, AH Jam-05, AH Jam-06, AH Jam-07, AH Jam-09, AH Jam-11, AH Jam-14, AH Jam-16, AH Jam-18, AH Jam-19, AH Jam-21 and AH Jam-23) have been found to be suitable at Jamalpur region.

Evaluation of off season jackfruit germplasm

The selected off-season jackfruit germplasm; AH Akb-001, AH Akb-003, AH Akb-008, AH Akb-015 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. The highest number of fruits was observed in AH Akb-001 (107) followed by AH Akb-015 (52) and AH Akb-003 (43). Maximum percent of edible portion was observed in AH Akb-003 (42.00%) followed by AH Akb-008 (41.81%). The highest TSS was recorded in AH Akb-008 (28%) followed by AH Akb-001 (26.0%). Considering the yield and yield contributing attributes, the germplasm AH Akb-001 exhibited superior results.

Evaluation of existing superior jackfruit lines

Performances of five jackfruit genotypes were studied at the Agricultural Research Station, Pahartali, BARI, Chittagong. Earliest flowering was observed in AH Pah-004 (Mid December) and the latest flowering was observed in AH Pah-001 and AH Pah-005, respectively (late January). Maximum harvesting duration was observed in AH Pah-004 (late April-late July). Maximum number of fruits per plant (120) was produced by AH Pah-004, whereas minimum fruits (35) were produced by AH Pah-005. The biggest fruit was observed in AH Pah-002 (8.310 kg) and the smallest was observed in AH Pah-005 (3.0 kg) followed by AH Pah-004 (3.32 kg). Individual bulb weight was noted higher (54.41g) in AH Pah-002 as compared to lower bulb weight (16.00) in AH Pah-001. Edible portion was recorded maximum (54.00%) in AH Pah-004 followed by AH Pah-001 (44.77%) as against minimum (36.10%) edible portion in AH Pah-005. TSS was noticed the highest (21.50%) in AH Pah-004, which was closely related to AH Pah-001 (21.00%). The bulbs of AH Pah-004 were excellent in taste. Considering flowering, fruit and other qualitative traits the genotypes AH Pah-001 and AH Pah-004 were found promising. This experiment will be continued in the next year.

Evaluation of jackfruit germplasm in the hill region

Evaluation of eleven preselected jackfruit germplasm namely, AH Kha-001, AH Kha-002, AH Kha-003, AH Kha-004, AH Kha-005, AH Kha-006, AH Kha-007, AH Kha-008, AH Kha-009, AH Kha-010 and AH Kha-011 of existing Jackfruit orchard was performed at the Fruit Farm of HARS, Khagrachari to identify superior small sized jackfruit germplasm with high yield potentiality and edible qualities. Yield and yield components of the jackfruit germplasm revealed that number of fruits per plant ranged from 25-103. AH Kha-005 produced maximum number of fruits followed by AH Kha-007 (91) and minimum number was in AH Kha-008. Among the eleven germplasm, six produced more than 75 fruits per plant indicating high yielding potentiality. TSS content of the fruit varied from 13-23. AH Kha-005 and AH Kha-010 produced the highest TSS (25%). Yield (kg/plant) was performed the highest (302.82 kg) in AH Kha-005 followed by AH Kha-010 (282.75 kg) and the lowest in the line AH Kha-008 (70.75 kg). The edible qualities were also excellent in some of the germplasm. Considering fruit characteristics i.e. taste, juiciness, sweetness, pulp colour, fruit number and yield of the germplasm, AH Kha-005, AH Kha-007 and AH Kha-010 were found to be suitable superior small sized jackfruit germplasm with high yield potentiality and edible qualities.

Evaluation of superior mango germplasm

Different quantitative and qualitative characteristics of three superior mango germplasm, namely, MI Joy-001, MI Joy-003, MI Joy-004, MI Joy-005 and MI Joy-006 grown at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur were studied. There were significant differences among the germplasm in respect of plant height, base girth, tree volume and spacing. Among the studied germplasm, MI Joy-001 had the highest plant height (5.43 m) and the lowest plant height was recorded in MI Joy-003 (3.20 m). MI Joy-001 showed the highest tree volume (155 m^3) followed by MI Joy-005 (123.33 m^3), while the lowest value was observed in MI Joy-003 (25 m^3). Full bloom took place from early to late February among the germplasm studied. All the germplasm had the mid season fruits harvested from 2nd week of June to last week of June. Number of fruits per tree varied from 55 in MI Joy-005 to 21 in MI Joy-003. Maximum fruit weight was recorded from MI Joy-006 (402.67 g) and mimimum fruit weight was recorded from MI Joy-001 (230 g). The germplasm MI Joy-004 exhibited the superiority in terms of TSS (25.73%). Considering overall growth condition, yield and fruit quality almost all the germplasm were appeared satisfactory. Among them, MI Joy-004 and MI Joy-005 were noticed as much promising germplasm. However, the experiment will be continued in the next year for drawing conclusion.

Evaluation of exotic mango germplasm

An experiment was conducted on the evaluation of five exotic mango germplasm (MI Ex Joy-001, MI Ex Joy-002, MI Ex Joy-003, MI Ex Joy-004 and MI Ex Joy-005) at the Fruit Research Farm of

Horticulture Research Centre, BARI, Joydebpur, Gazipur. MI Ex Joy-003 showed the highest tree volume (76.17 m^3), while the lowest value was observed in MI Ex Joy-002 (48.88 m^3). Full bloom took place from late January to late February, where MI Ex Joy-001 was the earliest and MI Ex Joy-005 was the latest. MI Ex Joy-005 produced maximum number of fruits per tree (44.33) while it was noted minimum in MI Ex Joy-003 (15.67). Maximum fruit weight was recorded in MI Ex Joy-003 (371.67 g) and minimum fruit weight was recorded in MI Ex Joy-005 (166.43 g). Total Soluble Solids were noted the highest in MI Ex Joy-002 (21.00%), which was statistically at par to that of MI Ex Joy-001 (19.33%), while the lowest TSS was found in MI Ex Joy-003(13.97%) and MI Ex Joy-005 (12.67 %). Among the germplasm, MI Ex Joy-001 was the most susceptible germplasm showing 4.11% vegetative malformation. Only Fruits of MI Ex Joy-003 was not infected by anthracnose, but the rest was infected by anthracnose. The overall growth condition of all the germplasm was satisfactory. Considering yield and quality MI Ex Joy-001, MI Ex Joy-002, MI Ex Joy-003 were found promising. The experiment will be continued up to next year for final recommendation.

Clonal selection of mango CV. Harivanga

The experiment was carried out at the Regional Agricultural Research Station, Burirhat, Rangpur with to develop high yielding good quality mango variety of harivanga. Twenty one 'Harivanga' germplasm were included in the study. Fruit harvesting was done from 2nd week of June to 1st week of July. Average fruit weight was noted maximum (384 g) in MI Har Bur-015, while minimum fruit weight (250 g) was noted in MI Har Bur-014. The percentage of TSS was recorded maximum (20) in MI Har Bur-002 and MI Har Bur-015 and MI Har Bur-018, while minimum TSS (17%) was recorded in MI Har Bur-011. The edible portion was received higher (76.81%) in MI Har Bur-007 compared to lower (67.38%) in MI Har Bur-014. The results revealed that the germplasm MI Har Bur-015 was good in respect of average fruit weight, percentage of TSS, pulp weight, edible portion and fruit bearing. So, the study should be continued in the next year for drawing final conclusion.

Collection and evaluation of some coloured mango germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapainawabganj. Thirty seven superior coloured mango germplasm MI Cha-001, MI Cha-002, MI Cha-004, MI Cha-005, MI Cha-007, MI Cha-008, MI Cha-009, MI Cha-010, MI Cha-011, MI Cha-012, MI Cha-013, MI Cha-014, MI Cha-015, MI Cha-016, MI Cha-017, MI Cha-018, MI Cha-019, MI Cha-020, MI Cha-021, MI Cha-22, MI Cha-023, MI Cha-024, MI Cha-25, MI Cha-026, MI Cha-027, MI Cha-028, MI Cha-029, MI Cha-030, MI Cha-033, MI Cha-034, MI Cha-035, MI Cha-36, MI Cha-037, MI Cha-038, MI Cha-039, MI Cha-040, MI Cha-041 regarding colour identified in the mango show 2008, were collected from different places of Rajshahi and Chapainawabganj district. Among the germplasm maximum tree volume (53.34 m^3) was recorded from MI Cha-008. On the other hand minimum tree volume (14.20 m^3) was noted in the germplasm MI Cha-037. All the germplasm produced flowers and out of these, 21 germplasm produced fruits this year. Individual fruit weight significantly varied from 130 to 650 g in the fruited germplasm. The germplasm MI Cha-020 and MI Cha-033 produced the biggest fruit of 650 g whereas the lightest (133 g) fruit was observed in MI Cha-011. Maximum yield regarding number (55) and weight (13.47 kg) of fruits per tree was recorded in MI Cha-009. On the other hand the lowest yield both in number and weight (3 and 0.69 kg, respectively) of fruits per tree was noted under MI Cha-001. MI Cha-020 had maximum edible portion (86.46%) while minimum of 53.84 % was recorded in MI Cha-011. Variations were also observed regarding qualitative characters of fruits like shape, skin colour at ripen, fruit attractiveness, adherence of skin to pulp, and skin thickness. Among the fruited germplasm MI Cha-001 and MI Cha-011 showed the highest incidence (80%) of post harvest anthracnose while the lowest incidence was noticed in MI Cha-013, MI Cha-017, MI Cha-018 and MI Cha-020 (20%). The highest incidence of stem-end rot (50%) was observed in MI Cha-015 as against the lowest incidence of 10% in MI Cha-040. Among the fruited germplasm, MI Cha-001, MI Cha-004, MI Cha-009, MI Cha-011, MI Cha-017, MI Cha-018 and MI Cha-035 were found promising in terms of qualitative characters like colour, TSS, shelf life and fruit attractiveness. The inferior genotypes might be heavy pruned and converted with superior genotypes.

Performance of SOM-1048 mango germplasm

An evaluation of SOM-1048 mango germplasm was performed at RHRS, Chapai Nawabgonj. The tree volume 43.88 m^3, fruit weight 450.00 g, fruit yield 40.50 kg, edible portion 82.22% and TSS 18.00 % were recorded in SOM-1048. Fruit fly infestation was recorded 25.20% at the time of harvest. Disease incidence to anthracnose was 20 % and stem end rot was absent. Shelf life was noted 6-7 days. But off-season performance was better compared to that of season bearing considering number of fruits, fibre in pulp and TSS (%). In the off-season, the SOM-1048 mango germplasm produced 170.00 fruits per plant. Individual fruit weight was recorded 330.0 g. The edible portion and the TSS were recorded 83.33 % and 19.00 %, respectively. Considering overall performances like late bearing habit i.e. harvesting time in August, yield, number of fruits, fruit weight, edible portion and total soluble solids, the SOM-1048 mango germplasm was noted well.

Performance of SOM-1049 off-season mango germplasm

A study to evaluate one mango germplasm SOM-1049 was performed at RHRS, Chapai Nawabgonj. Tree volume 15.31 m^3 was recorded in SOM-1049. The tree habit of SOM-1049 was spreading in nature. The plant height 3.50 m and base girth 10.00 cm were recorded in SOM-1049. The tree volume was recorded 15.31 m^3. Hevesting time was recorded from December to March. Fruit weight, fruit yield, edible portion and TSS were recorded 340.00 g, 5.10 kg, 80.88 % and 19.00 %, respectively. The SOM-1049 was good as per organoleptic test. Fruit fly infestation was absent at the time of harvest. In SOM-1049, disease incidence to anthracnose, stem end rot and floral malformation was absent. Shelf life was recorded 9-11 days. Considering overall performances like off-season bearing habit i.e. harvesting time (December to March), yield, number of fruits, fruit weight, edible portion and TSS, the germplasm SOM-1049 was noticed superior.

Evaluation of coloured mango germplasm

A study was carried out at the Horticulture Research Center, Regional Agricultural Research Station, Jessore to evaluate the colored mango germplasm. One coloured germplasm MI Jes-001 was included in the study. Plant height was 12.5 m and base girth was 2.2 m. The tree was spreading type. The germplasm showed earliness in flowering and harvesting. The date of flowering was 16th January 2016 and first harvest was done in 11th May 2016. The date of last harvest was 22nd May 2016. Total number of fruits per plant was 310 having individual fruit weight of 222 g. The edible portion was 67.48 % with 17.1 % TSS. The yield of mango per plant was 68.82 kg having 9 days of shelf life under room temperature. Considering attractive yellowish red fruit colour, fruit weight and yield, the germplasm MI Jes-001 was found promising. The study will be continued for further evaluation.

Evaluation of local mango germplasm

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet with 11 mango germplasm viz. MI Jai-006, MI Jai-007, MI Jai-010, MI Jai-015, MI Jai-020, MI Jai-025, MI Jai-026, MI Jai-027, MI Jai-031, MI Jai-040 and MI Jai-041. The highest plant height was recorded in MI Jai-007 while maximum base girth was found in MI Jai-017. MI Jai-007 showed the highest canopy size while MI Jai-021 was the lowest. Fruits of MI Jai-009 were harvested in late May which was early in the fruiting season and may consider as an early variety. The highest number of fruits per plant (1343) and the highest fruit yield/plant (233.68 kg) were obtained from MI Jai-005. The highest fruit weight was recorded in MI Jai-034 (237.0 g) followed by MI Jai-040 (230.0 g) and MI Jai-012 (227.0 g). The edible portion was noted the highest in MI Jai-017 (69.27%), whereas maximum TSS (17.2%) was obtained from MI Jai-020. Considering all the parameters, MI Jai-010, MI Jai-015, MI Jai-020, MI Jai-025, MI Jai-026, MI Jai-040 and MI Jai-041 may be considered for further study.

Performance of some popular and BARI released mango varieties under high rainfall area of north eastern region of Bangladesh

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet with four popular (Langra, Gopalbhog, Mollika, Kamala Sinduri) and three BARI released (BARI Mango-1, BARI Mango-2, BARI Mango-3) mango varieties. A wide variation was observed in case of growth and fruit characteristics. The highest plant height was observed in Mollica whereas BARI Mango-2 showed maximum base girth, canopy size, dense branching with excellent growth condition. The highest number of fruit/plant was found in BARI Mango-3 (92.00) while it was recorded the lowest in Mohonbhog (13.00). The highest fruit size was obtained from Mollica (13.5×8.43 cm) followed by BARI Mango-2 (9.63×8.37 cm). Maximum TSS (20.50%) was recorded from Gopalbhog. Maximum edible portion was found in Kamala sinduri (75.49%) followed by Gopalbhog (71.94%) while minimum was found in Langra (59.65%). Maximum yield was obtained from Molllika (6.26 t/ha) followed by BARI Mango-3 (4.3 t/ha) although fruit cracking was observed in Mollika variety. But BARI Mango-2 was exceptional retaining all the fruits without any cracking despite lower yield compared to Mollika and BARI Mango-3. Considering all the parameters BARI Mango-2 may be recommended for high rainfall area of north eastern hilly region. But final conclusion can be made after another one year of evaluation.

Performance of mango germplasm at Jamalpur region

A study including some local and exotic genotypes of mango viz. BARI Mango-1, BARI Mango-2, BARI Mango-3, BARI Mango-4, BARI Mango-8, BARI Mango-10, Khirsapat, Ranipachand, Langra, Mallika, Fazli, Harivanga, Gopalbhog, Himsagar, Subarnarekha, Surjapuri, MI Jam-002, MI Jam-003 and Hybrid-10 were conducted at the Fruit Farm of HRC, RARS, Jamalpur. BARI Mango-3 produced the highest number of fruits (322.00) as compared to the least fruits (22.00) in Hybrid-10. Fazli manifested the highest individual fruit weight (420.00g) as compared to the lowest in Ranipachand (157.00 g). BARI Mango-3 exhibited the best yield (53.45 kg/plant) as against the least yield 7.04 kg/plant in Himsagar. Harivanga showed the highest TSS (22.00 %). Hybrid-10 had the highest edible portion (80.53 %), whereas Harivanga exhibited the lowest edible portion (53.12 %). The results revealed that BARI Mango-2, BARI Mango-3, BARI Mango-4, BARI Mango-8, Khirsapat, Ranipachand, Langra, Gopalbhog, MI Jam-002 and MI Jam-003 exhibited superior performances under Jamalpur condition.

Evaluation of mango cultivars at RHRS, Norsingdi

Growth and phenological study was performed in BARI Mango-1, BARI Mango-2, BARI Mango-3 and BARI Mango-4, BARI Mango-7, BARI Mango-8, BARI Mango-9, Haribhanga and Pakistani at Norsingdi. Events of vegetative and reproductive flush were recorded including growth characters during October 2014 to 2016. Fruiting data were recorded in 2016. In all mango varieties, period of vegetative flash was recorded from March to January. The highest inflorescence length, number of male flowers and female flowers were recorded in BARI Mango-4 (33.66, 5.24 and 1.79%). The highest individual fruit was recorded in BARI Mango-4 (300.44 g), whereas the lowest in BARI Mango-3 (165.73). The highest TSS was recorded in BARI Mango-3 (20.56%) followed by Haribhanga (20.00%), whereas the lowest TSS was recorded in BARI Mango-2 (15.17%). Considering growth condition, individual fruit weight, fruit volume, TSS and percent of edible portion, BARI Mango-4 was noticed superior over all other varieties at Norsingdi. Also BARI Mango-2, BARI Mango-3 and Haribhanga were found to be promising for their satisfactory growth and other characteristics at Norsingdi region.

Performance of mango varieties/cultivars in Patuakhali region

Twelve mango varieties/cultivars viz. BARI Mango-1, BARI Mango-2, BARI Mango-3, BARI Mango-4, BARI Mango-5, BARI Mango-8, MIP-05, Khirshapat, Langra, Mollika, Gopalbhog and

Fazli was evaluated at RHRS, Lebukhali, Dumki, Patuakhali to evaluate their adaptability. The highest plant height was observed in BARI Mango-5 (125.00 cm) followed by BARI Mango-3 (100.67 cm) and the lowest plant height was observed in Mollika (51 cm). The highest base girth was observed in Fazli (61.33 cm) which was followed by BARI Mango-3 (57.67 cm) and the lowest base girth was found in Mollika (34 cm). BARI Mango-3 produced the highest number of fruits and yield, which were followed by BARI Mango-08. Langra produced the lowest number of fruits as well as yield per plant which was followed by BARI Mango-5. Considering yield and quality, BARI Mango-3, BARI Mango-4 and BARI Mango-8 showed better performance in Patuakhali region.

Evaluation of mango (Kanchamitha) germplasm

An experiment was conducted at RARS, Hathazari, Chittagong to evaluate Kanchamitha mango germplasm for superior traits. The germplasm MI Hat-001 produced 124 fruits. Average fruit weight was 228.0 g. Maximum percentage of edible portion was 64.75%. The TSS was recorded 7.5% at mature green stage and yield per plant was found 28.27 kg. The shape of the fruit was oblong having light green skin color at mature green stage. The organoleptic test of fruits was intermediate. Considering fruit quality, percent TSS, taste and yield, MI Hat-001 was found to be promising. The experiment will be continued to make on absolute recommendation.

Performance of mango (Kanchamitha) germplasm at hilly region

An experiment was conducted for evaluation of one mango germplasm (Kanchamitha) (MI Kha-001) at the Hill Agricultural Research Station, Khagrachari. The full blooming period was second week of January. Fruit harvesting period was 12th and 18th May 2016. The average individual fruit weight was recorded 258.2 g which was an acceptable size. Length and diameter of the fruit was recorded 13.19 cm and 6.56 cm, respectively Total Soluble Solids (TSS) was noted 9.0. Edible portion was found 70.37%. Overall qualitative characters were found excellent. Considering the fruit characters and edible quality, MI Kha-001 was observed promising for using in unripe condition. The experiment will be continued for final recommendation.

Evaluation of Kachamitha mango germplasm at hill valley in Chittagong hill tracts

A study was conducted at the existing three years old mango orchard containing MI Rai-005, MI Rai-006, MI Rai-007 and MI Rai-008 at the hill valley of the Hill Agricultural Research Station of Raikhali, Kaptai in Rangamati Hill District. The tallest plant (412 cm) was observed in MI Rai-006 and the shortest plant (222 cm) was recorded in MI Rai-007. The base girth ranged in between 51 cm and 31cm. The highest base girth (51 cm) was recorded in MI Rai-008, whereas the lowest base girth (31 cm) was noticed in MI Rai-005 and MI Rai-007. The highest number of fruits per plant (68) was found in MI Rai-007 and the lowest number of fruits per plant (12) was noticed in MI Rai-005. The heaviest individual fruit weight (194.2 g) was recorded in MI Rai-008 and the highest edible portion (76%) was found in MI Rai-005. On the other hand the lightest fruit weight (109.13 g) and the lowest edible portion (74.1) were recorded in MI Rai-007. Maximum TSS (8%) was manifested in MI Rai-006 and minimum TSS (6%) in MI Rai-005 and MI Rai-007. The genotype MI Rai-006 was observed very good in organoleptic test. Based on the number of fruits per plant and fruit yield, TSS, organoleptic test, individual fruit weight and edible portion, the germplasm MI Rai-006 and MI Rai-008 were observed superior among all other tested germplasm in the Chittagong Hill Tracts.

Evaluation of superior mango genotypes

Four genotypes of mango namely, MI Pah-001, MI Pah-002, MI Pah-003 and MI Pah-004 were evaluated at the Agricultural Research Station, Pahartali, Chittagong. The tallest plant (3.44 m) was observed in MI Pah-001 and the shortest plant (2.10 m) was observed in MI Pah-002. The highest base girth (40.33 cm) was produced by MI Pah-001, whereas the lowest (31.66 cm) base girth was recorded in MI Pah-004. Earliest flowering was observed in MI Pah-001 and the latest in MI Pah-004. Earlier harvesting was achieved in MI Pah-001 on the first week of May 2014 and the latest harvesting was achieved in MI Pah-004 on the first week of June 2014. The biggest fruit (393 g) was observed in MI Pah-003, which was closely related to that of MI Pah-004 (347 g) and the lightest fruit (163g) was observed in MI Pah-001. The highest edible portion (84.30 %) was noticed in MI Pah-003 and the lowest edible portion (65.72 %) was noted in MI Pah-001. Maximum Total Soluble Solids (TSS) (19.6%) was observed in MI Pah-004 and minimum TSS (17.8%) was observed in MI Pah-001. On the basis of earliness, fruit size, yield and quality, the germplasm MI Pah-002 and MI Pah-003 were noticed superior.

Characterization and evaluation of late mango germplasm

An experiment on characterization and evaluation of late mango germplasm was conducted at the Fruit Research Station, Rajshahi. The experiment included one late mango germplsm (MI Raj-002) which flowered two times in a year. First flowering occurred in the month of February and fruits were harvested in the mid season (June) and second flowering occurred in the month of May and fruits were harvested in the late season (September). The germplasm MI Raj-002 produced 186 number and 46 kg of fruits in the mid season of production during 2014-15. In case of late season production, the tree bore 140 number and 21 kg of fruits. The individual fruit weight of MI Rai-002 was 270 g in the main season and 152 g in the late season. Fruit contained 70.3% edible portion and 17% TSS in the main season, whereas the percentage of edible portion and TSS was 65.7% and 21% in the late season. Skin was thin and pulp colour was yellow. Fibre in pulp was present but it was palatable. Pulp texture was found very soft and juicy and pulp having pleasant flavor. Considering two times production and good flavor, the germplasm can be considered as a promising germplasm. The experiment will be carried out for the next year for further investigation.

Evaluation of exotic mango germplasm

An exotic mango germplasm (MI Raj-001) collected from Saudi Arabia was characterized at the Fruit Research Station, BARI, Binodpur, Rajshahi. The germplasm MI Raj-001 had 4 m of plant height and 38 cm of base girth. The tree was intermediate type of habit. Harvesting period of fruit was 2nd week of July. The germplasm MI Raj-001 produced 55 fruits. Average fruit weight was 440 g. Edible portion and TSS of MI Raj-001 were 76% and 19%, respectively. Edible portion and TSS of BARI Mango-4 were 78% and 17%, respectively. The fruit of MI Raj-001 had very attractive yellowish maroon colour at ripen. The growth condition and fruit characteristic of the germplasm MI Raj-001was noticed satisfactory. However, the experiment will be continued.

***In situ* evaluation of off-season mango germplasm**

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna to observe the performance of three off-season mango germplasm viz., SM Isd-001, SM Isd-002 and SM Isd-003. Flowering occurred almost at the same time i.e. last week of April in all the germplasm. But MI Isd-002 produced flower at two times. Another time of flowering was the First week of February. Among the three lines, MI Isd-002 was the early harvested than others. However, the highest number of fruits (400) and yield (99) per plant was obtained from the germplasm MI Isd-002. The highest individual fruit (248 g) was also recorded in MI Isd-002. The longest fruit (9 cm) was recorded from MI Isd-001 whereas, the shortest fruit (6.55 cm) was recorded from MI Isd-003. The highest TSS (17%) and edible portion (66.33%) were manifested in MI Isd-001 and the lowest TSS (15.50%) and edible portion (58.94%) were recorded in MI Isd-003. This is first year evaluation. So the experiment should be continued for the confirmation of the results.

Inter-varietal hybridization of mango

A hybridization programme was conducted at RHRS, Chapai Nawabganj. A total of 2,119 flowers from 383 panicles were emasculated and pollinated. Six hybrid fruits were obtained from the cross BARI Mango-3 x Palmer. Among the selected panicles, 2119 flowers were emasculated and pollinated. Total number of fruit retention at 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 days after pollination were 65, 45, 38, 30, 22, 15, 12, 9, 6, 6, and 6, respectively. These mango hybrid fruits were harvested at mature stage and stones of the fruits were sowed in soil at the hybrid seedling plot for germination. After germination, these one year hybrid seedlings will be transplanted in the main field and evaluated in the following seasons.

Hybridization of mango

A hybridization programme was conducted at ARS, Pahartali, Chittagong. A total of 23 panicles were selected for the hybridization programme. Among the selected panicles, 115 flowers were emasculated and pollinated. Total number of fruit retention at 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 and 110 days after pollination was always 1 (one). One hybrid fruit from the cross BARI Mango-11 (F) X BARI Mango-1 (M) was harvested. The stones of hybrid fruits obtained through crossing were sown in the soil for germination. After germination the seedling will be transferred to the main field for characterization and evaluation.

Evaluation of plantain germplasam

The experiment was conducted at the Regional Agricultural Research Station, Burirhat, Rangpur to find out a suitable plantain germplasm. Twenty two germplasm including BARI Banana-2 were in the study. All the germplam produced fruits. Maximum plant height at harvest (3.37 m) was recorded in MP Bur-019, while minimum plant height (2.40 m) was recorded in BARI Banana-2. Base girth was found maximum (62.33 cm) in BARI Banana-2 and minimum base girth (44 cm) was noticed in MP Bur-013. Maximum days to harvest (378.70) were required in MP Bur-020, which was similar (377) to that of MP Bur-016, whereas minimum days to harvest (341) were required by BARI Banana-2. Average finger weight was observed maximum (206.70 g) in MP Bur-001, which was similar (203.70 g) to that of MP Bur-002, while minimum (113.30 g) was recorded in MP Bur-018. Maximum fruit length (19.10 cm) was manifested in MP Bur-016 and minimum (13.50 cm) was noted in MP Bur-015. The highest diameter of fruit (5.67 cm) was found in MP Bur-001 as against the lowest diameter (4.37 cm) in MP Bur-011. BARI Banana-2 resulted in the highest yield (22.03 t/ha), which was statistically similar (21.47 t/ha) to that of MP Bur-020, while the lowest yield (12.27t/ha) in MP Bur-014. The experiment should be continued for further verification of the results.

Regional yield trial of plantain lines in Joydebpur region

To develop a suitable variety of plantain, a study to verify regional adaptability of a selected line (MP-014) with a check variety BARI Plantain-2 was performed at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur. The germplasm MP-014 produced taller plant (3.21 m) compared to that of BARI Plantain-2 (3.04 m). MP-014 exhibited maximum base girth (72.49 cm). Maximum top girth was recorded in BARI Plantain-2 (49.02 cm), while minimum was recorded in MP-014 (47.53). The germplasm MP-014 demonstrated maximum number of leaves (12.43) at the time of shooting compared to minimum in BARI Plantain-2 (12.14). Maximum number of leaves at harvest was also recorded in MP-014 (7.29) as compared to the minimum in BARI Plantain-2 (6.71). Days to shooting and harvest were noted maximum in BARI Plantain-2 (274.86, 363.00, respectively) compared to minimum in in MP-014 (271.00, 335.14, respectively). The germplasm MP-014 produced heavier bunch (20.27 kg) as compared to lighter bunch in BARI Plantain-2 (18.12 kg). Higher number of hands per bunch was recorded in BARI Plantain-2 (9.14). Maximum number of fingers per bunch and fingers per hand was recorded in BARI Plantain-2 (153.68, 16.89, respectively) as against minimum number of fingers per bunch in MP-014 (95.56, 13.01, respectively). The germplasm MP-014 produced the bigger finger (212.17 g). Maximum TSS and edible portion were recorded in MP-014 (5.48%, 62.10%, respectively). Higher (50.68 t/ha) fruit yield was obtained from MP-014 compared to that of BARI Plantain-2 (45.31 t/ha). Considering yield and yield contributing characters the germplasm MP-014 was appeared promising and awaiting releasing as a variety (BARI Banana-5).

Regional yield trial of plantain lines in Jamalpur region

A study on six local and exotic genotypes was conducted at the fruit farm and fruit characteristics were studied in the laboratory of the Horticulture Research Centre, RARS, BARI, Jamalpur to verify regional adaptability of selected lines and to find out the suitable variety for cultivation. The germplasm MP-24 produced the tallest plant (3.37 m) and BARI Banana-2 (2.73 m) had the shortest plant. MP-15 exhibited the highest base girth (61.11 cm) as against the lowest base girth in BARI Banana-2 (45.93 cm). The germplasm MP-18 demonstrated maximum number of leaves (8.14) as compared to minimum number of leaves in MP-15 (5.89). MP-15 produced the heaviest bunch (12.45 kg) as compared to the lowest bunch weight in BARI Banana-2 (7.54 kg). The highest number of hands per bunch was recorded in MP-15 (8.79), whereas the least number of hands was recorded in MP-24 (5.55). The germplasm MP-24 produced the biggest finger (189.35 g), while MP-15 had the smallest finger (160.00 g). The highest (27.74 t/ha) fruit yield was noted from MP-15 and the lowest fruit yield from BARI Banana-2 (16.33 t/ha). Considering yield and yield contributing characters the line MP-15 was found promising under Jamalpur condition.

Regional yield trial of plantain lines in Ishurdi region

Performance of five plantain lines viz. MP-01, MP-02, MP-15, MP-18 and MP-24 along with BARI Banana-2 as a check were studied at the Regional Agricultural Research Station, Ishurdi, Pabna. The highest plant height (2.89 m) was recorded in MP-24 and the lowest plant height (2.45 m) was recorded in BARI Banana-2. Maximum base girth (78 cm) was obtained from BARI Banana-2 and minimum base girth (58 cm) was recorded in MP-02 and MP-15. Early flowering (273 days) and harvesting (337 days) were recorded in MP-02 and later in BARI Banana-2 (315 days and 385 days, respectively). The highest average finger weight (191 g) was found in MP-01 and the lowest (132 g) in BARI Kola-2. The number of finger per bunch was noted maximum (72) in BARI Banana-2 and minimum (40) in MP-02. The highest bunch weight (10.07 kg) as well as yield (25.19 t/ha) was recorded in MP-24 and the lowest bunch weight (6.97 kg) as well as yield (17.42 t/ha) was obtained from MP-02. Considering yield, the plantain lines MP-24 and MP-01 were found superior. This is the first year trial. So it should be repeated in the next year for the confirmation of the results.

Clonal selection of banana CV. Champa

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet with 11 champa banana germplasm and BARI Banana-4 as check. A wide variation was observed regarding growth characteristics, where MS Jai-008 was noticed superior with regard to plant height, base girth, leaf size and growth condition followed by MS Jai-010, MS Jai-001 and MS Jai-005. Maximum bunch weight (10.8 kg), hand weight (0.9 kg) and finger weight (40 g) was obtained from the germplasm MS Jai-008 (10.8 kg). Yield was also manifested the greatest in MS Jai-008 (47.99 t/ha). Edible portion was recorded higher in MS Jai-002 (87%). All the two collected germplasm produced higher TSS (28%) over control (BARI Banana-4). Considering the growth and fruit quality parameters MS Jai-008 was found promising. Final conclusion will be made after two to three years evaluation.

Regional yield trial of table banana grmplasm

A study to see the regional adaptability of a selected superior line with a check variety BARI Banana-3 to develop suitable variety was conducted at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur. The germplasm MS Jes-001 produced taller plant (3.78 m) compared to BARI Banana-3 (3.68 m). The germplasm MS Jes-001 exhibited higher base girth (82.30 cm) as against lower base girth in BARI Banana-3 (81.37 cm). Days to shooting and harvest were noted higher in MS Jes-001 (332.00, 418.00) compared to minimum in BARI Banana-3 (319.71, 406.29, respectively). BARI Banana-3 produced biggeer finger (117.16 g) compared to smaller finger (86.84 g) in MS Jes-001. MS Jes-001 produced heavier bunch (20.27 kg) as compared to lighter bunch in BARI Banana-3 (18.12 kg). Higher number of hands per bunch was recorded in MS Jes-001 (13.66). Higher (50.79 t/ha) fruit yield was noted in MS Jes-001 compared to lower yield in BARI Banana-3 (49.04 t/ha). Considering yield and yield contributing characters, the germplasm MS Jes-001 was found promising.

Regional yield trial of banana lines in Jamalpur region

Six local and exotic genotypes were evaluated to identify the suitable lines/variety for regional adaptability at the fruit farm and in the laboratory of the Horticulture Research Centre, RARS, BARI, Jamalpur. Plant height at shooting varied from 1.60 m to 3.06 m, where ITC-570 was the shortest and Dud Sagar the tallest plant. The highest number of hands per bunch was recorded in ITC-1320 (12.33) and the least hands in Kabri (6.75). ITC-1320 got the highest number of fingers per hand (17.51) whereas, Kabri got the lowest (12.08) number of fingers. ITC-1320 produced the highest fruit yield (39.10 t/ha) closely followed by ITC-570 (34.39 t/ha) and Kabri produced the lowest yield (17.98 t/ha). ITC-1441 exhibited the highest edible portion (84.29%) as compared to the lowest edible portion in ITC-570 (73.33). ITC-1441 exhibited the highest shelf life (7.89 days) as compared to the lowest shelf life in ITC-1320 (5.08 days). Based on the results obtained from the experiment, it may be concluded that the germplasm, ITC-570, ITC-1320, Dudsagar and BARI Banana-1 performed better in terms of yield and quality.

Regional yield trial of banana lines in Ishurdi region

Performance of banana lines was evaluated at the Regional Agricultural Research Station, Ishurdi, Pabna to find out the suitable variety for the regional adaptability. Five lines viz., ITC-570, ITC-1320, ITC-1441, Dudh Sagar, Kabri and BARI Banana-1 as a check variety were used in the experiment. The tallest plant (259 cm) was recorded in Dudh Sagar, whereas the shortest plant (160 cm) was recorded in ITC-570. Dudh Sagar also produced maximum base girth (62 cm) and minimum base girth (53 cm) was recorded in ITC-570. The earliest inflorescence opening (290 days) and harvesting (395 days) were occurred in Kabri and delayed (355 days and 432 days, respectively) in ITC-1320. The highest number of hands per bunch (10) and fingers per hands (19) were found in ITC-1320. The highest bunch weight (17.05 kg) was observed in ITC-1320 and the lowest bunch weight (9.40 kg) was noticed in Dudh Sagar. The highest yield (42.63 t/ha) was obtained from the genotype ITC-1320, whereas the lowest yield (23.50 t/ha) was obtained from Dudh Sagar. Considering yield potentiality, ITC-1320 was found superior to others.

Evaluation of some seeded banana germplasm at jamalpur region

An experiment was carried out at the Fruit Farm and fruit characteristics were studied in the laboratory of the Horticulture Research Centre, RARS, BARI, Jamalpur. Eight local viz. SB-01, SB-02, SB-03, SB-04, SB-06, SB-09, SB-10, SB-13 and one exotic viz. SB-ISD-01 genotypes were included in the study. The line SB-03 produced the tallest plant (5.55 m) and SB-01 and SB-02 the shortest plant (3.17 m). Base girth and number of leaves were found maximum in SB-13 (69.67 cm) and SB-03 (8.33), respectively. The line SB-03 exhibited the highest bunch weight (21.08 kg) and number of hands per bunch (12.50.) The highest average weight of individual hand (1.95 kg) was found in SB-10. Number of fingers per hand was noted the highest in SB-02 (13.38). SB-10 exhibited the biggest finger (212.53 g) as against the smallest finger in SB-ISD-01 (98.67 g). The line SB-3 gave the maximum yield (49.29 t/ha), while SB-02 exhibited the minimum yield (25.76 t/ha). Considering yield and yield contributing characters, the lines; SB-03, SB-06, SB-09 and SB-10 were found promising under Jamalpur condition.

Development of population for gynodioecious papaya variety

A study on development of gynodioecious population for obtaining 100% productive plants with a view to increase farm income through papaya cultivation was carried out at the Fruit Research Farm of Pomology Division of HRC, BARI, Gazipur. Three sets of plants namely S_2 progeny of CP Joy-005, CP Joy-009 and BC_1 progeny were included in the study. Among the three sets S_2 progeny of CP Joy-005 produced 44.8, 43.1 and 12 percent andromonoecious, female and male plants, respectively; S_2

progeny of CP Joy-009 produced 30, 51 and 18 percent andromonoecious, female and male plants and the BC_1 progeny produced 7.2, 39.3 and 53.6 percent andromonoecious, female and male plants, respectively. Number of fruits per plant was recorded 32, 26 and 37 in CP Joy-005, CP Joy-009 and BC_1, respectively. Fruits of S_2 progenies showed bright yellow flesh colour but in BC_1 it was light pink to red in colour. TSS of fruits was 11.0, 13.0 and 12.0 in CP Joy-005, CP Joy-009 and BC_1, respectively. Seeds of S_2 and BC_1 progeny have been sown in the seed bed on December 2015. Evaluation of S_2 and BC_1 progeny along with new germplasm will be continued.

Purification of shahi papaya

An experiment was carried out at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur to purify the Shahi papaya variety. Seedlings of purified Sib-mated seeds were transplanted in the main field on February 2016 and the Sib-mating process (selfing of five flowers from each plant) for this year was started on May 2016. Upto June 2016, a total of 500 flowers were Sib-mated, among those 430 fruits were set. During the study years from 2007-08 to 2014-15, fruit weight ranged from 1.05 to 1.43 kg with an average of 1.15 kg and last year it was 1.11 kg, which was much higher than that of original Shahi papaya (0.95 kg). Pulp colour during 2007-08 to 2014-15 ranged from red to deep red. During 2014-15, TSS was recorded 13.00 %. From the results of the previous years' studies, it is clear that the experiment result of 2015-16 is very close to the original Shahi papaya and it may be expected that the pure Shahi papaya characters would be fully regained.

Purification of shahi papaya

An experiment was carried out at the Fruit Research Station, BARI, Binodpur, Rajshahi to purify the Shahi papaya variety. Seedlings of purified selfed seeds were transplanted in the main field on February 2015 and 10 flowers in each plant were selfed (Sib mating) from June to August 2015. A total of 800 flowers were selfed and among those, 772 fruits were set. The fruit length, fruit breadth, cavity length, cavity breadth, thickness ranged from 21-25cm, 34-41cm, 15-18 cm, 6-7 cm and 2-3.0 cm, respectively. TSS of this variety ranged from 9-11 (%). The flesh colour varied from yellowish red to red. The result revealed that the plant and fruit characteristics of Shahi papaya (BARI Papaya-1) under this experiment were not relevant to that of the original Shahi papaya. However, the study on purification of Shahi papaya should be continued for subsequent years to regain the characteristics of original Shahi pepaya.

Hybridization in litchi

Hybridization in litchi was performed out at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to incorporate some important characters like earliness, lateness, colour, regular heavy bearing in the desired variety or cultivar. Cross combinations for hybridization were: BARI Litchi-3 x BARI Litchi-4, BARI Litchi-2 x BARI Litchi-4, BARI Litchi-3 x BARI Litchi-1, Kathali x BARI Litchi-4, and Kathali x BARI Litchi-1 and initial fruit sets were noted 6, 4, 5, 5, 6 and 7, respectively. Finally, two fruits from each of the cross combination of BARI Litchi-3 × BARI Litchi-1 and Kathali × BARI Litchi-1 were harvested. Hybrid seeds of both the combinations were planted in the pots. Only the seeds obtained from Kathali × BARI Litchi-1 cross germinated. Initially two seedlings were obtained from the cross combination of Kathali ×BARI Litchi-1. The seedlings will be planted in the field for further evaluation for variety development. The experiment will be repeated for the next year.

Evaluation of guava in the hilly area of rangamati

An experiment was conducted with two guava genotypes *viz.*, PG Rai-003 and PG Rai-011 in the minor fruit orchard of Hill Agricultural Research Station, Raikhali, Rangamati Hill District. The germplasm PG Rai-003 was seedless, crispy, oblong shaped with extended keeping quality (8-10 days). Its individual fruit weight was 280 g. PG Rai-011 was less seeded, crispy with higher individual fruit weight (323.17 g). PG Rai-003 produced flower during June and became harvestable during

September and onwards. PG Rai-011 produced flower during April (on-season) and October (off-season) which became harvestable during February and onwards. Based on all the parameters under study, both the germplasm PG Rai-003 and PG Rai-011 exibited superior results for their specific values and PG Rai-003 may be released as an off-season seedless guava variety.

Performance of local promising guava genotype

Performances of the local guava genotype PG Pah-001 and BARI Guava-2 were studied at the Agricultural Research Station, Pahartali, Chittagong. Maximum number of fruits per plant (210) was recorded in PG Pah-001 and minimum (198) fruits were recorded in BARI Guava-2. Earliest flowering and fruit harvesting was recorded in BARI Guava-2 (25.03.16 and 01.06.16 respectively) and the latest was recorded in PG Pah-001 (10.04.16 and 04.06.16 respectively). The heaviest fruit was observed in PG Pah-001 (260 g) and the lightest fruit was observed in BARI Guava-2 (210 g). The thickness of mesocarp was recorded 1.97 cm in PG Pah-001 and 1.78 cm in BARI Guava-2. TSS in mesocarp and endocarp was recorded the highest in BARI Guava-2 (9.0% and 12.20%, respectively) and the lowest in PG Pah-001 (7.0% and 10.90% respectively). All the fruits had crispy flesh texture with a very good taste. Fruits of PG Pah-001 had medium soft seed and BARI Guava-2 had soft seed. On the basis of size, shape, crispiness and very good taste, the evaluated guava genotype PG Pah-001was found promising.

Hybridization in guava

A study was initiated at HRC, BARI, Gazipur on varietal improvement of guava through hybridization. Hybridization was done between BARI Payara-2, exotic - PG Ex-001, PG Ex-002, PG Ex-003, local PG 003 and PG 005 guava lines. Only two fruits (BARI Payara-2 x PG Ex 003 and BARI Payara-2 x PG 003) were harvested after successful crosses. Seedlings raised and planted for evaluation with closer spacing. The heaviest (341 g) fruit was obtained from HG-012 (20) followed by HG-012 (9) (314 g) while the lightest fruit (157 g) was obtained from HG-012 (36). The mesocarp thickness of fruit was maximum (2.13 cm) in HG-012 (20) followed by HG-012 (9) (1.94 cm), which was very near to its female parental line HG-012 (20). TSS in mesocarp was highest (8.41 %) in HG-012 (20) followed by HG-012 (9) (8.12 %) and lowest (6.11 %) in HG-012 (32) followed by HG-011 (4) (6.15 %). TSS in endocarp was highest (12.05 %) in HG-011 (7) followed by HG-012 (36) (11.51 %). It was lowest (9.70 %) in HG-011 (4). The number of seeds and weight of seeds per fruit were lowest in HG-012 (9) (274 and 3.11 g, respectively) and highest in HG-012 (20) (448 and 5.94 g). Among the F_1 lines, the highest number of fruits (61.23) was recorded in HG-011 (7) followed by HG-011 (3) (59.24), while the lowest number of fruits (23.25) was recorded in HG-012 (36). Maximum fruit yield (23.95 kg) was observed in HG-012 (20) and minimum (3.65 kg) in HG-012 (36). Fruits of HG-011 (4) and HG-011 (13) were observed crispy at early mature stage. Fruits of HG-011 (7) and HG-012 (36) were sweet in taste and rest of the F_1 hybrids produced medium sweet fruits. Among the F_1 lines, fruits of HG-012 (20) and HG-012 (9) were found to be promising in respect of fruit size, mesocarp thickness, crispiness, flavor, taste, yield and tolerance to insect pests. Considering fruit characteristics like fruit size, mesocarp thickness, crispiness, taste and yield per plant the F_1 lines; HG-012 (20) and HG-012 were found to be promising. The experiment will be continued for further observations.

Evaluation of coconut germplasm

The present study was conducted at CRS, Jaintiapur, Sylhet to evaluate the existing coconut germplasm. The highest plant height was observed in CN Jai-016 (15.2 m), whereas the lowest plant height was observed in CN Jai-012 (7m). Maximum base girth was rcorded in CN Jai-015 and CN Jai-023 (1.9 m), while minimum base girth was noted in CN Jai-012 (1.4 m). The highest number of fruits/plant (72), yield/plant (129.6 kg/plant) and yield (35.89 t/ha) was obtained from CN Jai-017. Tender nut was large in CN Jai-016 (29.3×18.2 cm) but CN Jai-023 was found with much water content (950 ml) followed by CN Jai-017 (790 ml). Comparatively sweet tender nut water was recorded from CN Jai-001 (TSS 10%). In case of mature fruit maximum fruit weight was found in CN Jai-016 (1900 g) but fruit size was noted the highest in CN Jai-017 (28.0×16.0 cm) with highest weight of fruit nut (1410 g) and maximum pulp weight (660 g). But the highest TSS (13%) of pulp was recorded in CN Jai-016. Considering quantitative and qualitative parameters, CN Jai-001, CN Jai-016, CN Jai-017 were noticed much superior to other germplasm. As the TSS of tender nut water was found maximum in CN Jai-001 hence it can be released as a variety for green coconut purpose. On the other hand, CN Jai-017 may be released for nut purpose.

Collection and evaluation of ber germplasm

An experiment to identify suitable ber germplasm was conducted at HRC Fruit Orchard, RARS, Jamalpur. Thirty nine accessions of ber were included in the study. Wide range of variation was noted regarding quantitative and qualitative fruit characters. Individual fruit weight ranged from 4.20 to 20.40 g, where ZM Jam-103 had maximum and ZM Jam-196 got minimum fruit weight. Number of fruit per plant varied from 758 to 4176. Yield per plant varied from 12.50 (ZM Jam-222) to 30.00 kg (ZM Jam-009). TSS varied from 10.50 in ZM Jam-185 to 20.67% in ZM Jam-24. Edible portion varied from 81.82 to 94.51%, where the line ZM Jam-188 had the least and ZM Jam-124 had the highest edible portion. Sweetness of fruit ranged from sweet to soury sweet, medium sweet, very sweet and sour. Taste the most important trait varied from good to very good. Cosidering individual fruit weight, number of fruits per plant, yield per plant, edible portion, TSS, crispiness, sweetness and taste, the germplasm ZM Jam-008, ZM Jam-009, ZM Jam-034, ZM Jam-103, ZM Jam-122, ZM Jam-124, ZM Jam-140, ZM Jam-182, ZM Jam-194, ZM Jam-223, ZM Jam-227, ZM Jam-239, ZM Jam-248 and ZM Jam-284 resulted in superior performance. Some lines viz. ZM Jam-122, ZM Jam-131, ZM Jam-140, ZM Jam-150, ZM Jam-151, ZM Jam-152, ZM Jam-157, ZM Jam-160, ZM Jam-163, ZM Jam-169, ZM Jam-182, ZM Jam-193, ZM Jam-194, ZM Jam-196, ZM Jam-202, ZM Jam-205, ZM Jam-222, ZM Jam-223, ZM Jam-227, ZM Jam-229, ZM Jam-235, ZM Jam-239, ZM Jam-248, ZM Jam-253 & ZM Jam-284 exhibited promising characters with soury sweet taste which is desirable to us. The experiment will be continued in the next year.

Collection and evaluation of ber germplasm

The present study was conducted at Citrus Research Station (CRS), Jaintiapur, Sylhet to evaluate the local ber germplasm. There were differences among the germplasm studied regarding plant height, base girth, spreading, number of branches/plant, number of fruits per plant and yield. The highest plant height and bigger canopy were observed in case of ZM Jai-003. Maximum number of fruits/plant (4515) as well as yield (35.40 t/ha) were obtained from ZM Jai-003. There were variations among the quantitative fruit characters. The largest fruit (4.25×3.6 cm) with maximum fruit weight (28.31 g) was observed in ZM Jai-003. Maximum TSS was found in ZM Jai-002 (11.8 %) while maximum edible portion was found in ZM Jai-003 (92.42 %). This is the result of third year study. Considering all the parameters, ZM Jai-003 was found superior among the germplasm tested. Further study is required for releasing it as a variety.

Collection and evaluation of ber germplasm

A study was conducted at the Fruit Research Station, Binodpur, Rajshahi with ten local and exotic ber varieties namely, ZM Bin-001 (Apple Kul)), ZM Bin-002 (BARI Ber-1), ZM Bin-003 (BARI Ber-2), ZM Bin-005 (Dhaka 90 Kul), ZM Bin-007 (Khulna Kul), ZM Bin-013 (BAU Kul), ZM Bin-012 (Local Kul Late), ZM Bin-014 (BARI Ber-3), ZM Bin-015 (China Kul) and ZM Bin-006 (Hazari kul). The germplasm ZM Bin-014 (BARI Ber-3) produced maximum fruit weight (60.00 g) and it was noted minimum in ZM Bin-001 (Apple Kul) (16.00 g). The highest total soluble solid (17.00%) was recorded in ZM Bin-002 (BARI Ber-1) while it was recorded the lowest (9.00%) in ZM Bin-015 and Chaina Kul. The highest edible portion was noted in Chaina Kul (95.23%) followed by Dhaka-90 Kul (95%). ZM Bin-014 (BARI Ber-3) gave the highest yield (25.61 t/ha) followed by ZM Bin-012 (Local kul late) (14.21 t/ha) and it was observed the lowest in ZM Bin-016 (Umboly Kul) (10.25 t/ha).

Vitamin C the most important component in ber fruits was found to be the highest in local kul late (85.63 mg/100 g), while it was noticed the lowest in Apple Kul (68.20 mg/100 g). Most of the ber varieties/lines were moderately susceptible to mealy bug. BARI Ber-1, China Kul and Local Kul Late were moderately susceptible to fruit borer. Among the germplasm/varieties, in terms of lateness Local Kul (Late) was found to be very promising.

Collection and evaluation of existing ber germplasm

An experiment with nine local (Apel kul, BARI Ber-1, BARI Ber-2, BAU Kul-1, Comilla Kul, Sabji Kul and Chapai Kul) and one exotic (Thai kul) germplasm was conducted at the Regional Horticulture Research Station, Chapai Nawabganj to find out the superior cultivars of ber for cultivation in that region as well as to find out the late variety. Chapai kul harvested on 15th April was considered as too late among the studied germplasm. Among the cultivars, Thai Kul produced the largest fruit (89.82 g) and Appel Kul produced the smallest fruit (26.44 g). The highest TSS (21%) was recorded in BARI Ber-1 and the lowest (16%) in Sabji kul. The highest (98%) and lowest (94%) edible portion were recorded in Thai kul and Chapai kul, respectively. The highest yield was obtained from Thai Kul (47.70 t/ha) and the lowest (23.26 t/ha) in Appel kul. Among the cultivars Apel Kul, BARI Ber-1, BARI Ber-2, BAU Kul-1, Thaikul, Chapai Kul and Dhaka 90 were moderately resistant to powdery mildew disease and rest of the cultivars were moderately susceptible. But in case of Sooty mould infection, BARI Ber-1, BAU Kul-1, Thai Kul and Dhaka 90 were found resistant at Chapai Nawabganj condition. Considering harvesting time, availability of fruits and taste, Chapai Kul may be released as a variety.

Collection and evaluation of local ber germplasm

A study was done on 20 ber germplasm which were collected from, Shibpur, Baelabo, Raipura, Monohordi, Sdarupazilla of Norsingdi district and also from Regional Horticulture Research Station (RHRS), Shibpur, Norsingdi to select the superior sour ber varieties. Among the studed ber germplasm the line ZM Nar-014 produced the largest fruit (12.73 g) and the line ZM Nar-004 produced the smallest fruit (5.78 g). The stone weight ranged from 0.82-1.66 g. The line of ZM Nar-014 exhibited highest (16.40%) TSS on the other hand line ZM Nar-005 exhibited the lowest (11.20%) value of TSS. Considering fruit size and other quantitative and qualitative characteristics, ZM Nar-006, ZM Nar-011 and ZM Nar-014 were found to be suitable. This survey will be continued for another 3-4 years including more collected germplasm for more precision.

Evaluation of indegenous ber germplasm at Khagrachari

A study with 32 local ber genotypes, namely ZM Kha-001, ZM Bin- Kha002, ZM Kha-003, ZM Kha-004, ZM Kha-005, ZM Kha-006, ZM Kha-007, ZM Kha-008, ZM Kha-009, ZM Kha-010, ZM Kha-011, ZM Kha-012, ZM Kha-013, ZM Kha-014, ZM Kha-015, ZM Kha-016, ZM Kha-017, ZM Kha-018, ZM Kha-018, ZM Kha-020, ZM Kha-021, ZM Kha-022, ZM Kha-023, ZM Kha-024, ZM Kha-025, ZM Kha-026, ZM Kha-027, ZM Kha-028, ZM Kha-029, ZM Kha-030, ZM Kha-031and ZM Kha-032 was conducted to select superior land races of indigenous ber for commercial cultivation at the Hill Agricultural Research Station, Khagrachari hill district. Average individual fruit weight ranged from 3.4 to 10.2 g. The genotype ZM Kha-32 produced the highest individual fruit weight (10.2 g) followed by ZM Kha-007 (9.80 g) and the lowest fruit weight in ZM Kha-029 (3.40 g). Edible portion ranged from 67.76% (ZM Kha-029) to 87.5% (ZM Kha-013). TSS varied from 11.0% (ZM Kha-006) to 23.6% (ZM Kha-021). Considering fruit characteristics, edible quality, TSS, percent and edible portion, the germplasm ZM Kha-032, ZM Kha-021, ZM Kha-023, and ZM Kha-005 were found promising.

Evaluation of mandarin germplasm in controlled condition at net house

The experiment was conducted at the Citrus Research Station, BARI, Jaintiapur, Sylhet with seven mandarin germplasm collected from various locations of Sylhet region along with BARI Mandarin-1 as check to find out the suitable varieties with higher yield and quality. A wide variation was observed in respect of yield and yield contributing characters of mandarin germplasm tested. The highest number of fruits per plant (32), yield per plant (4.86 kg) and per hectare yield (5.35 t) was found in CR Jai-017. Large fruit was observed in CR Jai-015 (188.15 g) with maximum fruit size (6.41×7.78 cm). No seed was observed in CR Jai-014. Edible portion was recorded the highest in CR Jai-017 (80.04%) but TSS was noted the highest in CR Jai-011 (12.6%). On the other hand Titratible acidity (TA) was recorded the lowest in CR Jai-014 (0.71%). Pulp firmness was soft to intermediate with medium to high juice content in all the germplasm. From the above result, it can be concluded that CR Jai-017 was noticed superior in terms of yield and quality and may be released as a variety.

Evaluation of superior lines of sweet orange

The study was conducted at the Citrus research Station, Jaintapur, Sylhet. Seven superior lines of sweet orange were tested with BARI Malta-1 as check. Significant differences were observed among the germplasm tested in terms of growth, yield, yield contributing and fruit characters. Maximum plant height was observed in CS Jai-001 (3.0 m), while minimum plant height was noticed in CS Jai-002 (1.5 m). Scion trunk diameter was noted the highest in CS Jai-009 (67 cm) followed by CS Jai-001 (65 cm), while the lowest scion trunk diameter was recorded in BARI Malta-1 (18 cm). Pulp weight and rind weight showed the similar pattern with maximum values from CS Jai-001 (565.0 g and 180.0 g, respectively) and minimum from BARI Malta-1 (92.50 g and 45.0 g, respectively). Maximum TSS was found in CS Jai-007 (9.7 %), while the lowest TSS was recorded in CS Jai-002 (7.6%). The germplasm CS Jai-001, CS Jai-002, CS Jai-005, CS Jai-007 and CS Jai-009 had high level of juice content, whereas medium juice content was observed in CS Jai-003, CS Jaio-004 and BARI Malta-1. The highest fruit weight (545.0 g) was obtained from CS Jai-001, while the lowest (160 g) fruit weight was obtained from BARI Malta-1. The highest number of fruit was found in BARI Malta-1 (242). Maximum yield (67.58 kg/tree and 42.23 t/ha) was manifested in CS Jai-001. Among the germplasm, CS Jai-003 can be released as a new sweet orange variety. However, the germplasm CS Jai-002 and CS Jai-001 were also observed promising.

Evaluation of sweet orange germplasm in hill region

Two sweet orange germplasm were evaluated at Hill Tracts Agricultural Research Station, Ramgarh. Higher plant height (4.01 m) and base girth (38 cm) were recorded in the germplasm CS Ram-001. Maximum number of main branches (2/plant) was recorded in BARI Malta-1. The line CS Ram-001 has the highest canopy with E-W spread and N-S spread. Maximum number (135.7) and weight of fruits (24.52 kg) were obtained from the germplasm CS Ram-001. TSS was recorded higher (7.10%) in BARI Malta-1 followed by CS Ram-001 (7.08%). The result indicates that the line CS Ram-001 is promising and can be released as a variety.

Evaluation of local pummelo lines

Evaluation of local pummelo lines was done at the Citrus Research Station, Jaintapur, Sylhet to study their performances. All the lines showed significant variation in respect of plant height, base girth, number of fruits/plant, yield/plant and fruit quality attributes. Maximum plant height and base girth were recorded in CG Jai-008. The highest number of fruits per plant (40.25) was found in CG Jai-001, which also produced the biggest (1068.0 g) fruit. Maximum yield/plant was recorded in CG Jai-008 (38.4 kg) with maximum fruit size (14.38×14.45 cm). The highest edible portion was obtained from CG Jai-007 (60.59%), while the lowest edible portion was found in CG Jai-011 (48.04%). Maximum TSS was recorded in CG Jai 008 (10.23%) followed by CG JAI 009 (9.40%) and CG Jai-007 (9.25%), respectively. The germplasm CG Jai-007 was found promising in respect of yield, per cent edible portion and per cent TSS and may be released as a new variety of pummelo.

In-situ evaluation of year round pummelo germplasm

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari. One off-season pummel germplasm (CG Kha-001) was selected for the evaluation along with a normal season control. Mainly two season bearing occurred in the germplasm. Fruit weight ranged from 1.57 kg to 1.18 kg. Maximum edible portion was obtained from the control (48.02%) with the highest TSS (10%), while it was 39.14% in the off-season line with a TSS value of 9.0%. The highest number of fruits (154) was collected from the line CG Kha-001. In the qualitative characteristics of the fruits it was found that the flesh colour of the advanced line was pink. Flesh of the off-season line was soft, juicy, bitterless and very sweet in organoleptic test. Therefore, the line CG Kha-001 was noticed promising for year round pummelo cultivation at the hilly region.

Evaluation of local pummelo germplasm

Eight selected pummelo germplasm viz. CG Akb-0144, CG Akb-0151, CG Akb-0154, CG Akb-0161, CG Akb-0163, CG Akb-0173, CG Akb-0177 and CG Akb-0184 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. The highest number of fruits (89) was obtained from the line CG Akb-0161 followed by CG Akb-0151 (87). Fruit weight of the germplasm CG Akb-0144 was recorded the highest (1050.0 g) followed by CG Akb-0161(920.0 g) while it was noted the lowest in CG Akb-0173 (710.0 g). Number of segments ranged from 11 to 15. The highest edible portion (59.98%) was found in CG Akb-0184 followed by CG Akb-0177 (56.67%). TSS ranged from 9 to 12 %. The lines CG Akb-0144, CG Akb-0151, CG Akb-161 and CG Akb-173 were bitterless. Considering fruit size, bearing and quality of fruits the lines CG Akb-0144 and CG Akb-0151 were observed promising.

Evaluation of pummelo in hilly region of Rangamati

An experiment with eleven pummelo genotypes *viz.*, CG Rai-001, CG Rai-002, CG Rai-004, CG Rai-005, CG Rai-006, CG Rai-007, CG Rai-008, CG Rai-009, CG Rai-010, CG Rai-011 and CG Rai-013 was conducted at the existing eight years old pummelo orchard at the hill valley of Hill Agricultural Research Station of Raikhali in Rangamati Hill District. The tallest plant (430 cm) was observed in CG Rai-001 and the shortest (290 cm) plant was observed in CG Rai-005. The highest plant base girth (53 cm) was recorded in CG Rai-001 and the lowest base girth (43 cm) was recorded in CG Rai-002. Time of first flowering varied in between mid February to mid March. The earliest flowering (Mid February) was noted in CG Rai-001 and CG Rai-002 and the latest (mid March) flowering was noticed in CG Rai-013. Maximum number of fruits per plant (210) was observed in CG Rai-008 followed by CG Rai-009 (150), whereas minimum (06) fruits were noted in CG Rai-013. Good quality fruit was observed in CG Rai-005 by organoleptic test. Based on the edible portion (%), TSS (%), bitterness, organoleptic test and colour, the genotype CG Rai-005 was noticed superior and can be released as a variety.

Collection and evaluation of colombo lemon germplasm at Norsingdi region

The experiment was conducted at the research field of Regional Horticulture Research Station, BARI, Shibpur, Norsingdi with five Colombo lemon germplasem. Significant variation was observed in case of growth, yield contributing characters, yield and fruit quality of the germplasm studied. The highest plant height (4.02 m) was recorded in CL Nar-005, while the lowest value (2.90 m) was found in CL Nar-001. Base girth (0.14 m) was noted the highest in CL Nar-004. Maximum number of fruits/plant (89.01) and yield (15.31 t/ha) were obtained from CL Nar-005. On the other hand minimum (81.62) number of fruit/plant and yield (229.06 t/ha) were recorded in CL Nar-003. Fruit size was the highest in CL Nar-005 (13.46×7.60 cm^2) followed by CL Nar-004 (12.65×6.75 cm^2). The highest edible portion (61.19 %) and TSS (7.13 %) were noticed in CL Nar-005. Among the germplasm, CL Nar-005 was found free from disease, whereas the other lines suffered from gummosis. Leaf miner was common in case of all the germplasm. Contemplating yield, edible portion, TSS, disease and insect infestation, the germplasm CL Nar-005 showed the best result among the germplasm.

Evaluation of colombo lemon germplasm

Two germplasm of Colombo lemon viz. CL Joy-001 & CL Joy-002 were evaluated on the basis of their qualitative as well as quantitative characters. The highest rind thickness (0.75 cm) and pulp diameter (6.5 cm) were recorded in CL Joy-002. Juice content was recorded maximum (24%) in the germplasm CL Joy-002 and minimum in CL Joy-001(22%). The highest amount of vitamin-C (33.24 mg) and titrable acid (5.41%) was found in the germplasm CA Joy-002. The heaviest fruit (315 g) was noticed in CL Joy-002. Maximum number of fruits (70) as well as yield per plant (22.05 kg) was also recorded from the germplasm CL Joy-002. Minimum leaf miner infestation was observed in both the germplasm. There was no mite infestation sign in all the two studied germplasm but there were some thrips infestation signs in the germplasm CL Joy-002. On the other hand, there was no symptom of disease (canker and gummosis) infection in both the germplasm. The accession CL Joy-002 resulted in superiority in terms of fruit number and yield without any disease and little insect infestation.

Collection and evaluation of jara lemon germplasm

Six lines of jara lemon such as CM Akb-001, CM Akb-002, CM Akb-003, CM Akb-004, CM Akb-005 and CM Akb-006 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. Maximum single fruit weight (840.0 g) was obtained from CM Akb-001 followed by CM Akb-003 (825.0 g) and CM Akb-002 (455.0 g). Fruit length ranged from 7.50 cm (CM Akb-006) to 17.50 cm (CM Akb-001) and fruit breadth was 4.75 cm (CM Akb-006) to 12.0 cm (CM Akb-001). The highest rind thickness was also obtained from CM Akb-001 (2.40 cm) and the lowest rind thickness was 0.53 cm in CM Akb-006. Number of fruits per plant was recorded the highest in CM Akb-006 (55.0) and the lowest in CM Akb-003 (7.0). Considering fruit size and rind thickness the line CM Akb-001 was found promising.

Evaluation of lime germplasm

Seven germplasm of lime were collected from different parts of Bangladesh and planted in the Fruit Research Farm, HRC, BARI, Gazipur on August 2013 under Citrus Development Project (BARI Part). Among them five germplasm viz, CA Joy-001, CA Joy-002, CA Joy-003, CA Joy-004 and CA Joy-005 were evaluated on the basis of both qualitative and quantitative characters. The highest plant height (250.00 cm) was noticed in CA Joy-002 followed by CA Joy-005 (220.00 cm) and lowest plant height (158.33 cm) was in CA Joy-003. The germplasm CA Joy-001 had higher number of seeds per fruit (41.00) and the germplasm CA Joy-003 had the lowest number of seeds per fruit (15.00). The germplasm CA Joy-001 had the highest amount of juice (29%) and vitamin-C content (37.37 mg), while the germplasm CA Joy-003 had highest amount of total acid content (8.33%). The heaviest individual fruit weight (84.45 g) and maximum number of fruits per plant (268.00) were recorded in the germplasm CA Joy-001. Similarly, maximum yield per plant (22.61 kg) was also recorded in the germplasm CA Joy-001 followed by CA Joy-004 (16.27 kg). Considering yield and quality, the accession CA Joy-001 was noticed superior.

Collection and evaluation of kaghzi lime (*Citrus aurantifolia*)

Six lime germplasm viz. CA Rah-01, CA Rah-02, CA Rah-03, CA Rah-04, CA Rah-05 and CA Rah-06 were evaluated at RARS, Rahmatpur, Barisal. Wide variations in growth characteristics among the germplasm were observed. Among the germplasm, the highest plant height was attained in CA Rah-01 (4.9m) and the lowest one was in CA Rah-06 (2.3m). The highest base girth was found in the germplasm CA Rah-001 (30 cm) and the lowest base girth was noted in CA Rah-04 (12 cm). The highest total number of fruits was found in CA Rah-01 (590) and the lowest fruit was noticed in CA Rah-04 (80). In case of average fruit weight, the heaviest fruit was harvested from CA Rah-02 (41.6g) and the lightest fruit was obtained from CA Rah-01 (28.2). The highest yield was found in the germplasm CA Rah-01 (16.64 kg/plant) and the lowest in CA Rah-03 (2.84 kg/plant).

Collection and evaluation of existing bael germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapai Nawabganj including 22 bael germplasm to find out the good ones. Among the fruit characteristics, fruit weight varied from 650 g (AM Cha-019) to 2600 g (AM Cha-004), pulp weight from 415 g (AM Cha-003) to

2150 g (AM Cha-004), fibre weight from 34 (AM Cha-001) to 90 g (AM Cha-004), seed weight from 11 g (AM Cha-015) to 45 g (AM Cha-003) and TSS from 25 % (AM Cha-014) to 36 % (AM Cha-003, AM Cha-004). Maximum pulp (above 82.69%) was recorded in AM Cha-004. The least seeded genotypes were AM Cha-004, AM Cha-014 and AM Cha-002. Fruit yield was recorded the highest from AM Cha-001 (19.8 t/ha) and the lowest from AM Cha-011 and AM Cha-12 (1.0 t/ha). Among the germplasm, AM Cha-008 and AM Cha-009 were considered as early and fruits were harvested on 15 March. Seven germplasm were late with harvesting on end of April. In consideration of fruit characteristics, edible portion, bitterness, mucilage and flavour, AM Cha-002, AM Cha-004, AM Cha-006, AM Cha-09, AM Cha-010, AM Cha-013, AM Cha-015 and AM Cha-020 were found promising. Genotypes having less seeds and mucilage content, less fibre content and better aroma can be used for improvement of this native fruit. Among the genotypes AM Cha-005 has been released as BARI Bael-1.

Evaluation of bael germplasm

The experiment to evaluate the bael germplasm was carried out at Citrus Research Station (CRS), Jaintapur, Sylhet. Five bael germplasm viz. AM Jai-001, AM Jai-002, AM Jai-003, AM Jai-004, AM Jai-005 were included in the study. The highest plant height was recorded in AM Jai-004 (10.9 m), whereas the lowest plant height was observed in AM Jai-002 (4.5 m). Maximum base girth was manifested in AM Jai-005 (132 cm). The highest number of fruits (132) was found in AM Jai-003 with maximum yield (31.85 kg and 8.82 t/ha, respectively). There were variations among the quantitative fruit characters. Maximum fruit weight was obtained from AM Jai-004 (550 g) with large sized fruit (11.2×10.4 cm). The germplasm AM Jai-001 was noted superior with maximum TSS (40%) and edible portion (63.76%). Among the germplasm tested, AM Jai-001 and AM Jai-004 were found superior.

Evaluation of bael genotypes

The experiment was conducted at the Regional Agricultural Research Station, Burirhat, Rangpur. Out of seventy five genotypes, only 11 genotypes had fruits this season. The genotype AM Bur-17 resulted in the tallest plant (6.75 m), while AM Bur-24 gave the shortest plant (4.52 m). On the other hand, maximum base girth (0.65 m) was recorded in AM Bur-17 and minimum base girth (0.40m) was found in the genotype AM Bur-50. Time of harvesting was observed from 2nd week of March to 4th week of April. Maximum number of fruits per plant (25) was harvested from AM Bur-50, followed by AM Bur-28 (20), whereas minimum number of fruits (5) was recorded from AM Bur-31, AM Bur-42 and AM Bur-43. The genotype AM Bur-50 produced maximum yield per plant (13.75 kg), followed by AM Bur-28 (12.50 kg), while AM Bur-42 produced minimum (1.75 kg) yield per plant. Heavier and bigger fruits were recorded in the genotypes, AM Bur-31, AM Bur-17, AM Bur-28 and AM Bur-50. Weight of fruits of those genotypes ranged from 550g to 750g. The genotypes AM Bur-24, AM Bur-26, AM Bur-33, AM Bur-37, AM Bur-42, AM Bur-43 and AM Bur-73 produced lighter fruit in weight (<500g). The genotype AM Bur-31manifested maximum pulp weight (455 kg), while AM Bur-26 gave minimum pulp weight (166 g). Fruits of genotype AM Bur-37 contained maximum seeds (115) as as against minimum seeds in AM Bur-42 (25). Maximum edible portion (79.45) was recorded in AM Bur-50. Fruit pulp was found sticky, soft, non-gritty and bitter less in the genotypes, AM Bur-17, AM Bur-37 and. AM Bur-42. Considering fruit size, shape and quality, the genotypes AM Bur-17, AM Bur-37 and AM Bur-42 were found superior.

Evaluation of bael in hilly area of Rangamati

An experiment on the evaluation of bael in the hill valley was conducted at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District. The germplasm AM Rai-003 produced higher number (23) of fruits, each fruit weighing 1340 g. Maximum edible portion (70.6%) and TSS (37.9%) were recorded in the germplasm AM Rai-003. The genotype AM Rai-002 contained slightly bitterness but in case of AM Rai-003 bitterness was completely absent. Fruits of AM Rai-003 were very sweet and organoleptic test was very good. According to the performance in terms of edible portion, TSS%, organoleptic test and other parameters, the germplasm AM Rai-003 was found suitable for cultivation in the hilly areas and might be released as a new bael variety.

Collection and evaluation of cowa germplasm

Growth characteristics of eleven cowa germplasms (viz. GC Rah-01, GC Rah-02, GC Rah-03, GC Rah-04, GC Rah-05, GC Rah-06, GC Rah-07, GC Rah-08, GC Rah-09, GC Rah-10 and GC Rah-11) were evaluated at the RARS, Rahmatpur, Barisal. Wide variations in growth characteristics among the germplasm were found. The highest plant height was attained in GC Rah-07 (472 cm) and the lowest plant height in GC Rah-10 (210 cm). The highest base girth was found in the germplasm GC Rah-11 (59 cm) and the lowest value was in GC Rah-09 (25 cm). The highest total number of fruits per plant was found in the germplasm GC Rah-06 (980). The highest individual fruit weight was noted in GC Rah-06 (43.20 g) and the lowest fruit weight in GC Rah-02 and GC Rah-08 (33.00 g). The highest yield was manifested in the germplasm GC Rah-06 (42.34 kg/plant) and the lowest yield was attained in GC Rah-10 (8.53 kg/plant).

Evaluation of cowa germplasm

The experiment was conducted at the Citrus Research Station (CRS), Jaintapur, Sylhet with five cowa germplasm. A wide variation was observed with regard to plant height, base girth, spreading, number of fruits/plant, fruit weight, edible portion and per cent TSS of different germplasm tested. The highest plant height, base girth, canopy size and number of fruit were bserved in GC Jai-004. Maximum yield/plant (144.0 kg) and yield/ha (14.4 t) were obtained from GC Jai-018. Fruit weight was noted the highest in GC Jai-001 (24.16 g). Maximum per cent edible portion (43.5%) was obtained from GC Jai-004 but the germplasm GC Jai-018 was noted superior in terms of per cent TSS (14.3%). Considering growth, yield and quality, the germplasm GC Jai-001, GC Jai-004 and GC Jai-018 were found promising.

Evaluation of custard apple germplasm in hilly region

Ten custard apple germplasm viz. AS Ram-001, AS Ram-002, AS Ram-003, AS Ram-004, AS Ram-005, AS Ram-006, AS Ram-007, AS Ram-008, AS Ram-009, AS Ram-011 were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. The line AS Ram-005 produced maximum number of fruits (41/plant) with heavier fruit (219.2 g/fruit). Maximum fruit yield (8.97 kg/plant) was obtained from the line AS Ram-005. Maximum TSS (19.41%) was recorded in AS Ram-003 closely followed by AS Ram-005 (18.67%). Based on the yield and quality, it might be concluded that the custard apple germplasm AS Ram-005 was observed superior.

Collection and evaluation of custard apple genotypes

Evaluation of sixteen custard apple germplasm i.e. AR Cha-01, AR Cha-02, AR Cha-03, AR Cha-04, AR Cha-05, AR Cha-06, AR Cha-07, AR Cha-08, AR Cha-09, AR Cha-10, AR Cha-11, AR Cha-12, AR Cha-13, AR Cha-14, AR Cha-15, AR Cha-16 was performed at the Regional Horticulture Research Station, Chapainawabganj. Sixteen genotypes were collected from five upazils of Chapai Nawabganj district. A wide variation was observed among the germplasm regarding fruit weight, fruit shape and harvesting time. Among the genetypes, AR Cha-06 produced bigger fruits (290 g). Total soluble solids (TSS) of different cultivars varied from 16 to 25%. The highest (25%) TSS was recorded in AR Cha-06 and AR Cha-14 and the lowest TSS was noticed in AR Cha-01 (16%). Eating quality and fruit attractiveness were also satisfactory for most of the genotypes. Among the genetypes, AR Cha-06 was noticed superior.

Collection and evaluation of custard apple germplasm

Fruit characteristics of thirteen custard apple germplasm viz. AS Raj-001, AS Raj-002, AS Raj-003, AS Raj-004, AS Raj-005, AS Raj-006, AS Raj-007, AS Raj-008, AS Raj-009, AS Raj-010, AS Raj-

011, AS Raj-012 and AS Raj-013 were studied in the laboratory of Fruit Research Station, BARI, Binodpur, Rajshahi. The result indicated that wide range of diversity existed in fruit weight, pulp weight, TSS, pulp content and skin weight. The highest fruit weight (150 g) was observed in AS Raj-004 and the lowest fruit weight was observed in AS Raj-006 (68.40 g). The skin weight was noticed the highest (63.83 g) in AS Raj-004 and the lowest (29.80 g) in AS Raj-006. The highest TSS (25%) was recorded in AS Raj-002 as against the lowest TSS was recorded (18%) in AS Raj-O08 and AS Raj-O09. On the basis of fruit weight and TSS value, the germplasm AS Raj-004, AS Raj-011, AS Raj-012 and AS Raj-002 exhibited better performance.

Evaluation of burmese grape germplasm

The experiment was performed at CRS, Jaintiapur, Sylhet, with six Burmese grape germplasm. A wide variation was observed in case of growth, yield contributing characters, yield and fruit quality of the germplasm studied. The highest plant height was recorded in BS Jai-017 (5.1m), while the lowest plant height was found in BS Jai-018 (3.5 m). Base girth was recorded the highest in BS Jai-017 and BS Jai-020 (48 cm). Fruit weight ranged from 10.02 g to 15.1 g, where BS Jai-012 was found to be the highest. Edible portion was recorded maximum from BS Jai-014 (65.62%) and TSS from BS Jai-011 (13.5%). The highest number of fruits/plant (1790) and yield (18.5 kg/tree, 8.6 t/ha) were noticed from BS Jai-020. From the above results, the germplasm BS Jai-011, BS Jai-014 and BS Jai-020 were found promising.

***In-situ* evaluation and collection of superior burmese grape genotype**

In-situ evaluation of Burmese grape was conducted at the Farmers field, Shibpur, Norsingdi with seven Burmese grape germplasem. Wide variation was observed in case of growth, yield contributing characters, yield and fruit quality of the germplasm. Maximum number of fruits/plant (3000) and yield/plant (87.50 kg) were manifested in BS Nar-002. The heaviest (24.54 g) fruit was obtained from BS Nar-002, while the lightest (12.50 g) fruit was noticed from BS Nar-006. Maximum edible portion was also recorded from BS Nar-002 (56.68 %) as compared to minimum in BS Nar-006 (39.36 %). Maximum edible portion (56.68%) and percent TSS (16.05%) were noticed in BS Nar-002. The germplasm BS Nar-002 was also free from disease, whereas the other germplasm suffered from powdery mildew and sooty mould. Chaper beetle was common in case of all the germplasm. Contemplating yield, edible portion, TSS, disease and insect infestation, the germplasm BS Nar-002 showed the best result among the germplasm. This is the first year evaluation, further study is needed to evaluate more precisely.

Evaluation of burmese grape germplasm

Nine Burmese grape lines i.e. BS Akb-018, BS Akb-019, BS Akb-023, BS Akb-029, BS Akb-031, BS Akb-032, BS Akb-037, BS Akb-039 and BS Akb-043 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. Maximum single fruit weight (15.08 g) was obtained from BS Akb-037 followed by BS Akb-043 (13.62 g) and minimum in BS Akb-039 (8.90 g). The highest skin weight was found in the line BS Akb-037 (7.76 g) and minimum in BS Akb-039 (3.97 g). The highest TSS was obtained from BS Akb-043 (15.20%) and the line was very good in taste. Number of fruits was recorded the highest in BS Akb-043 (1364) and the lowest in BS Akb-023 (33). Considering yield and quality, the germplasm BS Akb-043 was found better among the germplasm and may be recommended as variety through further study.

Evaluation of wax jambu germplasm

The experiment was conducted at the Regional Agricultural Research station, Akbarpur, Moulvibazar with 5 wax jambu lines viz. BS Akb-001, BS Akb-002, BS Akb-003, BS Akb-004 and BS Akb-005. Maximum individual fruit weight (50.0 g) was obtained from BS Akb-003 and BS Akb-005 and minimum was recorded in BS Akb-004 (33.34 g). Maximum number of fruits per plant was observed in BS Akb-001 (2550) and minimum fruits were recorded in BS Akb-002 (51). Considering fruit size, number of fruits and fruit quality, the line BS Akb-001 was found promising. After further evaluation it may be recommend for release as variety.

Evaluation of wax jambu at norsingdi region

An investigation was conducted at RHRS, Shibpur, Norsingdi to evaluation three wax jumbu lines for the development of variety. The highest individual fruit weight 45.57 g was obtained from EJ Nar-002 and the lowest fruit weight 9.04 g was obtained from EJ Nar-001. The highest number of fruit cluster 5.80 was obtained from EJ Nar-001, whereas the lowest cluster number 4.30 was obtained from BARI Wax jambu-1. Maximum TSS (5.12%) was obtained from EJ Nar-002 and minimum (3.20%) was obtained from EJ Nar-001. The highest yield (64.46 kg/plant) was recorded in BARI Wax jambu-1, whereas the lowest (16.55 kg/plant) yield was recorded in EJ Nar-001. The germplasm EJ Nar-002 was sweeter than other germplasm. Fruits of all the germplasm exhibited very attractive color, among them BARI Wax jambu-1 was deep purple; EJ Nar-001 was bright pink and EJ Nar002 was creamy white. All the germplasm produced fruit once in a year except EJ Nar-001, which bore fruits three times in a year. Considering fruit size, yield and quality, the lines EJ Nar-002 was found promising. After further evaluation it may be recommended as a variety.

Evaluation of exotic wax jambu germplasm

One exotic wax jambu germplasm (SS Bin-001) with a check BARI Jmrul-1 were evaluated at the Fruit Research Station, BARI, Binodpur, Rajshahi. The germplasm (SS Bin-001) was a small spreading tree having plant height of 5.3 m and base girth 65 cm. The white flowers and resulting fruits were not limited to the axils of the leaves, instead came out from any point on the surface of the trunk and brunches. Fruit length was noted maximum in SS Bin-001 (7.16 cm) and the lowest was BARI Wax jambu-1 (5.84 cm). The wax jambu (SS Bin-001) flesh has a very loose wave, which is crispy and slightly aromatic in test. The very middle holds a seed situated in a sort of cotton candy-like mesh. This mesh is edible but flavorless. Individual fruit weight of SS Bin-001 ranged from 55-66 g and TSS was 12%. Maximum amount of total sugar (2.01%) was obtained from SS Bin-001 and minimum sugar was (10.66%) noticed in BARI Wax jambu-1. Vitamin C was found to be the highest in SS Bin-001 (5.641 mg/100 g), while the lowest in BARI Wax jambu-1(4.019mg/100 g). Vitamin A was manifested higher in SS Bin-001 (87.12 mg/100 g) compared to BARI Wax jambu-1 (32.212 mg/100 g). The germplasm SS Bin-001 showed better performance on the basis of fruit weight, crispiness, organoleptic test and TSS value.

Evaluation of golden apple germplasm in the hilly region

Seven golden apple germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. The line SD Ram-001 produced maximum number of fruits (3388/plant), while bigger fruit (102.6 g) was produced by the line SD Ram-002. Maximum fruit yield (309.33 kg /plant) was obtained from the line SD Ram-002 and the minimum yield (17.3kg/plant) was recorded in SD Ram-006. Considering yield and yield contributing characters the lines SD Ram-001 and SD Ram-002 were observed superior.

Evaluation of Indian dillenia germplasm

The present study was conducted at CRS, Jaintiapur, Sylhet to evaluate the local Indian dillenia germplasm. Three Indian dillenia germplasm was included in the study. There were differences among the germplasm studied regarding plant height, base girth, plant spreading, number of branches/plant, number of fruits per plant and yield. The highest plant height, base girth and size of leaf were observed in DI Jai-003. The germplasm DI Jai-001 was noted superior with bigger canopy size. Maximum number of fruits/plant was obtained from DI Jai-001 (225) while minimum fruits were recorded in DI Jai-002 (210). The highest yield was also noticed in DI Jai-003 (181.46 kg/plant and 50.26 t/ha), while the lowest yield was recorded in DI Jai-002 (144.9 kg/plant and 40.13 t/ha). Large fruit was obtained from DI Jai-003 (870 g). TSS and edible portion were manifested maximum in DI Jai-003 (5.3% and

80.0%, respectively). Considering yield and quality, the germplasm DI Jai-003 was found superior to the other lines tested.

Evaluation of indian dillenia germplasm in hilly region

Five Indian dillenia germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. The highest plant height (24.25 m) was recorded in DI Ram-005 (Table 1) but maximum base girth (205 cm) was noted in DI Ram-003. The line DI Ram-003 produced maximum number of fruits (598/plant), while heavier fruit (803.6 g/fruit) was produced by the line DI Ram-005. Maximum fruit yield (433.94 kg /plant) was obtained from the line DI Ram-005 and minimum yield (78.95kg/plant) was recorded in DI Ram-004. Considering yield and yield contributing characters the line DI Ram-005 was noticed superior.

Collection and evaluation of wood apple germplasm

Seven wood apple germplasm were evaluated at the Fruit Research Farm of HRC, BARI, Gazipur. Among them, two germplasm did not have any fruit, only flowers were initiated. No variation was observed in plant height, base girth, and canopy spread (E-W and N-S direction). Most of the fruit characters did not show any significant variation except fruit length and rind weight of fruit, which exhibited significant variation. The highest (243 g) and the lowest (109.67 g) fruit weight were observed in FL Joy-001 and FL Joy-007, respectively. In case of fruit length, FL Joy-003 exhibited maximum fruit length (7.49 cm), whereas FL Joy-007 exhibited the lowest fruit length (6.10 cm). TSS ranged from 13.00 % to 15.33%, where FL Joy-006 had maximum (15.33 %) and FL Joy-007 contained minimum (13.00 %) TSS content. Pulp colour of the germplasm was brown to light brown and intermediate to excellent in taste. The fruits of all the germplasm were harvested from 1st week of November to 1st week of December 2015. The highest number of fruits per plant was obtained from FL Joy-004 (32.00) as against the lowest in FL Joy-003 (20.67). The study revealed that the germplasm FL Joy-004, FL Joy-005 and FL-Joy 06 were found superior with respect to quantitative and qualitative characters and fruit yield.

Evaluation of wood apple in hilly area of rangamati

An experiment to evaluate three wood apple germplasm in the hill valley of Hill Agricultural Research Station, Raikhali, Rangamati Hill District was performed. Maximum plant height (510 cm), base girth (60 cm) and canopy (640 × 580 cm^2) was recorded in FL Rai-003. The germplasm FL Rai-001 and FL Rai-002 were harvested during December-January (season), on the other hand FL Rai-003 and FL Rai-004 were harvested during February-April (off-season). The highest individual fruit weight (476 g), fruit length (8.6 cm), fruit breadth (9.0 cm) and skin thickness (0.4 cm) were recorded in the germplasm FL Rai-004. Maximum yield per plant (59.9 kg) and edible portion (57.9 %) were manifested in FL Rai-003 and it was also very well in organoleptic test. According to the performance of yield, organoleptic test and off season characteristics, the germplasm FL Rai-003 was found suitable for cultivation in the hilly areas and may be released as a wood apple variety.

Evaluation of Indian olive germplasm

The present study was conducted at CRS, Jaintiapur, Sylhet to evaluate the local Indian olive germplasm. Thirteen Indian olive germplasm were included in the study. There were differences among the germplasm studied regarding plant height, base girth, spreading, number of branches/plant, number of fruits per plant and yield. The highest plant height was observed in EF Jai-013 (4.5 m) followed by EF Jai-014 (4.2 m), whereas the lowest plant height was manifested in EF Jai-001 and EF Jai-004 (3.1 m). Maximum base girth was resulted in EF Jai-002, EF Jai-007 and EF Jai-013 (90 cm) followed by EF Jai-006 and EF Jai-014 (89 cm) and minimum in EF Jai-008 (78 cm). The germplasm EF Jai-007 (42.0 g) exhibited maximum individual fruit weight. The highest number of fruits/plant was obtained from EF Jai-009 (1880) and maximum yield was obtained from EF Jai-007 (59.39 kg/plant and 23.75 t/ha respectively). The highest flesh thickness was found from EF Jai-002, EF Jai-

003, EF Jai-007 and EF Jai-013 (1.5 cm), while the edible portion was noticed higher in EF Jai-007 (90.52%). In case of fruit shape EF Jai-009 yielded elongated shape fruit, Elliptic shape fruit was found in EF Jai-002, EF Jai-004, EF Jai-005, EF Jai-006 and EF Jai-010, while other germplasm yielded oval shaped fruit. On the basis of yield and quality, the germplasm EF Jai-007 was noticed superior.

Survey, collection and evaluation of jamun germplasm

An experiment was conducted at the Fruit Research Station, BARI, Binodpur, Rajshahi to evaluate nine jamun lines for superior traits (survey on different area in Rajshahi). Wide variations were observed among the germplasm. The tallest tree was noted in SC Bin-001, (15 m) as against the dwarf tree in SC Bin-013 (4.5 m). Maximum base girth (90 cm) was recorded in SC Bin-005 and minimum base girth was recorded in SC Bin-004 (48 cm). The highest fruit weight (11 g) was obtained in SC Bin-006, SC Bin-013 and SC Bin-015 followed by SC Bin-005 and SC Bin-014 (10 g). Maximum edible portion (85%) was obtained from SC Bin-005 followed by SC Bin-008 (84%), whereas minimum edible portion (72.50%) was noticed in SC Bin-004. The highest TSS 20% was obtained from SC Bin-013. Maximum yield per plant was recorded form SC Bin-005 (50 kg) followed by SC Bin-001 (47 kg). Minimum yield per plant was recoded in SC Bin-006 and SC Bin-014 (20 kg). Considering percent TSS, edible portion and yield, the germplasm SC Bin-005 and SC Bin-012 were recorded superior over other germplasm.

Evaluation of jamun in hilly area of Rangamati

An experiment with four jamun genotypes was conducted on three years old jamun genotypes established in minor fruit block of Hill Agricultural Research Station, Raikhali, Rangamati Hill District. The tallest plant (320 cm) was recorded in SC Rai-004 followed by SC Rai-008 (300 cm), whereas the shortest (250 cm) plant was observed in SC Rai-009. The plant base girth ranged between 30 cm and 45 cm. Maximum base girth (45 cm) was recorded in SC Rai-004 and minimum base girth (30 cm) was noticed in SC Rai-009. The highest canopy spreading (350 cm × 370 cm) was noted in SC Rai-004 and the lowest (200 cm × 210 cm) in SC Rai-009. The highest number of fruits per plant (1856) as well as yield per plant (22.2 kg) was recorded in SC Rai-004 but the lowest fruits (869) were found in SC Rai-009. On the other hand, maximum fruit size (3.3 cm × 2.8 cm), individual fruit weight (14.2 g), flesh thickness (9.23 mm), edible portion (85. 2%) and TSS (19.0 %) were recorded in SC Rai-009. Fruits of all the genotypes were black in color, oblong in shape with flat fruit apex. The organoleptic test of SC Rai-008 was very good. Based on fruit size, individual fruit weight, flesh thickness, edible portion, TSS (%), organoleptic test and fruit yield, the genotypes SC Rai-004, SC Rai-008 and SC Rai-009 were supposed to be superior and might be released as variety for commercial cultivation.

Evaluation of jamun germplasm at hars Khagrachari

Twenty jamun germplasm was evaluated for their fruit characteristics at the existing plantation in the fruit orchard of HARS, BARI, Khagrachari. Maximum size and weight of individual fruit were noted in SC Kha-006 and minimum in SC Kha-008. Out of twenty, seven germplasm showed their superiority in respect of fruit size. The edible portion of the different germplasm also varied widely and ranged from 73.21% - 99.93%. The TSS % of the germplasms ranged from 12% - 15.6%. Considering fruit characteristics, edible quality, TSS, percent edible portion and yield potentialities, the germplasm B(2) , B(3), A(5), C(4) and C(5) were found promising. Considering fruit characteristics, edible quality, TSS, edible portion and yield potentialities, the germplasm B(2) , B(3), A(5), C(4) and C(5) were noticed promising.

Evaluation of lukluki (*Flacourtia jangomes*) germplasm

Ten lines of lukluki viz. FJ Akb-004 FJ Akb-006, FJ Akb-007, FJ Akb-008, FJ Akb-011, FJ Akb-012, FJ Akb-016, FJ Akb-017, FJ Akb-020 and FJ Akb-021 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. Maximum single fruit weight (9.85 g) was obtained from FJ

Akb-007 followed by FJ Akb-004 (8.21 g) and minimum fruit weight was noticed in FJ Akb-012 (4.86 g). The highest pulp weight was found from the line FJ Akb-007 (6.35 g) and minimum was in Lu-Akb -016 (2.42 g). The number of seeds (11.63) and weight of seeds/fruit was also moderate in the line FJ Akb-007 (1.25 g). The highest TSS was manifested in FJ Akb-007 (20.0%) and the line was very good in taste. The line FJ Akb-007 was found better among the germplasm and may be recommended as variety through further study.

Life cycle events of dragon fruit genotype at Norsingdi region

The experiment was conducted to evaluate six dragon fruit genotypes at RHRS, Shibpur, Norsingdi. Initiation of 1st flower took place on the last week of April 2015 and the range of flash number was recorded from 6 to 8. Range of bud to flower setting was measured from 15 to 18 days and flower to fruit setting was measured from 6 to 7 days. The highest length of flower was recorded in HU Nar-04 (31.00 cm). Weight of individual fruit varied from 143.27 g to 340.213 g, where maximum fruit weight was recorded in HU Nar-06 and minimum fruit weight was recorded in HU Nar-05. The highest fruit number was manifested in HU Nar-04 (23), whereas the lowest fruit number was noted in HU Nar-03 (15). The highest yield per pillar was recorded in HU Nar-04 (6.42 kg), whereas the lowest yield was observed in HU Nar-05 (2.29 kg). Maximum edible Portion and TSS were recorded in HU Nar-01 (77.72 %, 14.5%, respectively). Considering morphological, floral and fruit characteristics, the germplasm HU Nar-01, HU Nar-04 and HU Nar-06 performed better compared to other genotypes.

Performance of dragon fruit germplasm at hill slope

The experiment was carried out at HARS, Khagrachari to determine the performances of dragon fruit germplasms in the hill slope. Maximum individual fruit weight (390 g) was recorded from BARI Dragonfruit-1 followed by HU Kha-002 (303 g) but minimum fruit weight (213 g) was noted in HU Kha-001. The highest number of fruits per pillar (24) was observed in BARI Dragonfruit-1 and the lowest in HU Kha-001 (9). The highest edible portion (87.81%) was obtained from BARI Dragonfruit-1, whereas the lowest (78.75%) edible portion was recorded in HU Kha-001. Maximum TSS (21%) was found in BARI Dragonfruit-1 followed by HU Kha-002 (19%), while minimum (18%) TSS was noted in HU Kha-002. Considering flowering time and fruit bearing habit, fruit characteristics i,e taste, juiciness, sweetness, colour of pulp and yield, all the three germplasm may be suitable for cultivation in the hill slope.

Evaluation of avocado lines

Six lines of avocado germplasm viz. PA Akb -001, PA Akb -002, PA Akb -003, PA Akb -004, PA Akb-005 and PA Akb -006 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. The observed plant height ranged from 611.0 cm in PA Akb-006 to 835.0 cm in PA Akb-002. Base girth was maximum (132.0 cm) in AR-Akb-002 and minimum (91.0 cm) in AR-Akb-004. Bearing of fruits was highest in PA Akb-003 (145) followed by PA Akb-005(122) and PA Akb-002(77). Two lines PA Akb-001 and PA Akb-006 had not bear any fruits yet. In case of fruit characteristics PA Akb-005 line performed best in case of individual fruit weight (215.25g), weight of seed (45.5g), fruit and seed size respectively. The line PA Akb-005 performed better and the experiment will be continued for final conclusion.

Evaluation of phalsa (*Grewia asiatica L.*) in the hilly area of Rangamati

An experiment on the evaluation of phalsa germplasm was performed at the established minor fruits orchard of Hill Agricultural Research Station, Raikhali, Rangamati Hill District. Four germplasm were included in the study. Maximum plant height (590 cm), base girth (61 cm) and canopy (590 × 540 cm^2) were recorded in GA Rai-002. Time of harvest was same for all the germplasm and it was in the month of May. Maximum number of fruits per plant (19200) and fruit yield (4.5 t/ha) were noticed in the genotype GA Rai-002. On the other hand the highest TSS (26.6 %) was recorded in the genotype

GA Rai-004. According to the performance of number of fruits per plant, fruit length and fruit yield, the genotype GA Rai-002 was found promising.

Evaluation of phalsa (*Grewia asiatica L.*) germplasm

One germplasm of phalsa (GA Bin-001) was evaluated at the Fruit Research Station, BARI, Binodpur, Rajshahi. The germplasm (GA Bin-001) was a small spreading tree having plant height of 9.7 m and base girth of 0.90 m. The yellow flowers were born in dense cymes in the leaf axils during March to May. The fruit was round, drupe and become dark purple when ripe. The flesh color was light greenish white. The length and breadth of the fruit were 1.03 cm and 1.01 cm, respectively. Length of peduncle was 2-3 cm. Fruit flavor was slightly astringent. Weight of fruit, seed and flesh of 100 fruits was 49 g, 7.98 g and 41 g, respectively. The edible portion and TSS were 84% and 23.9%, respectively. Number of seed per fruit was 1-2. Opaque, brown, round or hemispherical seed showed low seed shattering.

Evaluation of star gooseberry in hilly area of rangamati

An experiment was conducted at the Hill Agricultural Research Station of Raikhali, Kaptai under Rangamati Hill District for the evaluation of nine years old five star gooseberry genotypes i.e. PA Rai-001, PA Rai-002, PA Rai-003, PA Rai-004 and PA Rai-005. Plant height varied from 530 cm to 460 cm. Maximum plant height (530 cm) was observed in PA Rai-002, whereas minimum plant height (460 cm) was observed in PA Rai-003. The highest plant spreading (486 cm × 471 cm) was noted in PA Rai-005 and the lowest plant spreading (480 cm × 420 cm) was noticed in PA Rai-002.The highest number of fruits per plant (13796) was recorded in PA Rai-004 and the lowest fruits were noted (11812) in PA Rai-002. Two fruiting times per year were observed in all the treatments providing fruits almost round the year. Maximum individual fruit weight (4.03 g), TSS (7.99 %) and very good organoleptic test were obtained from PA Rai-001 with a fruit yield of 52.64 kg/plant/year. Based on individual fruit weight, organoleptic test, TSS (%), number of fruits and yield per plant, the germplasm PA Rai-001 was supposed to be superior and might be recommended as a new variety.

In-situ evaluation of palmyra palm germplasm

In-situ evaluation of eight palmyra palm (*Borassus flabaellifer* L.) germplasm viz. BF Joy-001, BF Joy-002, BF Joy-003, BF Joy-004, BF Joy-005, BF Joy-006, BF Joy-007 & BF Joy-008 was performed at different parts viz. Gazipur, Madaripur and Lakshmipur of Bangladesh during the period from August to September 2015. Fruit harvesting date ranged from 11 August to 09 September 2015. The highest plant height (14.5 m) was recorded in the germplasm BF Joy-006. Maximum base girth (232 cm) was noticed in the germplasm BF Joy-008. Number of bunch per tree (28) and the number of fruits per bunch (25) were recorded the highest in the germplasm BF Joy-001. The heaviest fruit (2.42 Kg) was observed in BF Joy-001. Only the germplasm BF Joy-006 exhibited hard peeling quality and the germplasm BF Joy-005, BF Joy-007 and BF Joy-008 exhibited medium peeling quality, while the rest exhibited easy peeling quality. Bitterness was absent only in the germplasm BF Joy-006 but the rest of the germplasm exhibited slight bitterness. The highest TSS (20%) was recorded in BF Joy-006. Maximum edible portion (75.6%) was recorded in BF Joy-007 and the best yield (1.69 t/plant) was recorded in BF Joy-001. The highest amount of vitamin-C (8.56 mg) was found in BF Joy-001. Total sugar (8.11%) and reducing sugar (6.30%) were recorded maximum in BF Joy-006. The highest amount of β-carotene (385.120 μg) was found in the germplasm BF Joy-006 followed by BF Joy-001 (363.872 μg).

Propagation Technique

Effect of rootstocks on growth, disease incidence and yield of guava varieties

An experiment to investigate the effect of rootstocks on growth, disease incidence and yield of guava varieties was conducted at the Fruit Research Farm, Horticulture Research Center, BARI, Gazipur to find out the survivability and field performances of grafted and non-grafted guava plants. There were eight treatments in this experiments, viz., Kazi Peyara grafted on L-49, BARI Peyara-2 grafted on L-49, Kazi Peyara grafted on poly peyara, BARI Peyara-2 grafted on poly peyara, BARI Peyara-2 grafted on strawberry guava, seedling plant of BARI Peyara-2, goottee of Kazi peyara and BARI Peyara-2. Grafted plants were planted in the field in May 2013. Maximum plant height (2.86 m), base girth (14.73 cm), canopy spread (N-S 2.48 cm and E-W 2.73 cm) and number of primary branches (2.86) were recorded in seedling plant of BARI Peyara-2. The highest number of flowers (294.30) and fruits (38.21) was thinned from the plants of BARI Peyara-2 grafted on L-49 rootstock. Maximum fruit retention (45.32) per plant was obtained from BARI Peyara-2 when grafted on L-49 rootstock. As L-49 and Poly Peyara exhibited tolerance against wilt, grafting technique using L-49 and Poly Peyara may impart wilt tolerance to improved guava varieties. L-49 was found as the most suitable rootstock for getting higher success, survivability, growth as well as number flowers and fruits for BARI Peyara-2 grafts.

Effects of time and variety on grafting of litchi

An experiment was performed at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to study the effects of time and variety on grafting of litchi. Scions of 3 litchi germplasm namely BARI Litchi-3, China-3 and Early Bedana were used for grafting in the months of January, February, March and April. Time of grafting and variety alone and in combination influenced the success of grafting, days required to budbreak, number of leaf, leaf blade length and leaf blade width of litchi. The highest success was achieved in January grafting with the scion BARI Litchi-3 (72.4%) followed by China-3 (64.3 %) and Early Bedana (62.5%). The lowest success was noticed in Early Bedana in April (26.4%). January grafting with BARI Litchi-3 took minimum time (20.4 days) to bud break and March grafting with Early Bedana took 30.5 days. Maximum number of leaves was found in January grafting with BARI Litchi-3 (6.80).

Effect of tricho-compost and tricho-leachate in maintenance of strawberry plantlets in the nursery bed as well as their subsequent growth and development in the main field

Effect of soil amendment through tricho-compost as soil application and tricho-leacheate as foliar spray alone or in combination were studied on maintenance of plantlets in the nursery and their subsequent growth and development in the main filed. BARI Strawberry-1 was used in this experiment. The lowest sapling mortality (6.67 %) was recorded when plants sprayed with tricho-leacheate (T_3) while, the highest plant mortality (16.67%) was recorded in control. Number of runner production per plant (3.81) was found maximum in the plants grown in soil fertilized with tricho-compost and foliar application of tricho-leacheate. The highest TSS content (10.77) was recorded in fruits harvested from plants under soil fertilized with tricho- compost (T_1). The highest yield/plant (621.68 g) and yield per hectare (13.81 ton) were obtained from the plant in grown under combined application of tricho-compost and tricho-leacheate (T_3).

Cultural Management

Split application of fertilizer on grafted jackfruit plant

An experiment was conducted at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur to study the effects of split application of fertilizer on grafted jackfruit plant. All the treatments produced fruit. There were 5 fertilizer treatments per plant, viz. T_1: NPK 300-130-300 g, T_2: NPK 450-200-450 g, T_3: NPK 600-260-600 g, T_4: NPK 750-320-750 g and T_5: Only Cow dung 20 Kg/plant. Fertilizers were applied at 3 installments: 1st- 50% (N and K) and other fertilizers in September/October, 2nd- 25% (N and K) after fruit set, 3rd- 25% (N and K) after 60 days of fruit set. Gypsum-400 g, Boric acid- 50 g and cow dung @ 20 kg/plant were used as blanket dose. The highest plant height was observed in T_4 (5.23 m) followed by T_5 (5.16 m) and T_3 (4.73 m). The lowest plant height was found in T_2 (4.16 m). The highest base girth was recorded in T_4 (52.5 cm) and the lowest in T_1 (48.0 cm). The treatment T_3 with NPK (600-260-600 g/plant) produced the highest number of fruit

(11.40) and the lowest number of fruits was found in T_5 (4.46). The total fruit yield per plant was significantly influenced by different treatments. The highest fruit yield per plant was recorded in the treatment T_3 (82.5 Kg) followed by T_4 (58.4 Kg). The lowest fruit yield per plant was obtained in T_5 (28.9 Kg). The treatment NPK : 600-260-600 g/plant along with Gypsum- 400 g, Boric acid- 50 g and cow dung @ 20 kg/plant was the best for fruit yield and earliness in fruit bearing of grafted jackfruit. Experiment on split application of organic matter will be undertaken.

Effect of growth regulators and other chemical on growth, flowering, fruiting, yield and quality of mango

An experiment to investigate the effects of growth regulator on fruit retention as well as yield and quality of mango was carried out at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur. Six treatments namely NAA 40 ppm, NAA 40 ppm + urea at 2%, 2,4-D 12 ppm, 2,4-D 12 ppm + urea at 2%, urea at 2% and control (water spray) were included in the study. The longest terminal shoot was noted in the plants treated with NAA 40 ppm (18.00 cm) and the shortest terminal shoot was noticed in the treatment 2,4-D 12 ppm (15.06 cm). At harvest, 2,4-D 12 ppm + urea at 2% exhibited the highest fruit retention per panicle (1.84) closely followed by urea at 2% (1.60). Always from fruit set to fruit harvest, control plants had the lowest fruit set per panicle which was 0.42 at harvest. The lowest number of fruit (26.3) and the highest fruit weight were observed in control treatment (367 g) compared to the smallest fruit (282 g) in 2,4-D 12 ppm + urea at 2%. The highest yield was noted in the treatments urea at 2% (68.44 kg/plant) followed by 2,4-D 12 ppm + urea at 2% (59.80 kg/plant). Plants sprayed with water that is control had the least yield (9.52 kg/plant). All the treatments exhibited higher fruit retention as well as yield in mango over control. Maximum yield was recorded in the treatments urea at 4% (68.44 kg/plant). Plants sprayed with water (control) had the least yield (9.52 kg/plant).

Effect of irrigation on fruit drop in mango

An experiment was carried out to find out the effect of irrigation on fruit retention as well as yield and quality of mango at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur. There were four irrigation treatments i.e. 2, 4 and 6 irrigations each at an interval of 10 days and control (no irrigation). The longest panicle was recorded in the treatment 4 irrigations at an interval of 10 days (25.53 cm) which was statistically at par to that of 2 irrigations at an interval of 10 days (23.17 cm). Control exhibited the shortest panicle (18.47 cm). Fruit retention per panicle at all dates exhibited significant influence due to irrigation. From 18.03.15 to harvest of fruit, always 2 irrigations at an interval of 10 days gained higher fruit retention per panicle which was 1.20 at harvest. The lowest fruit retention per panicle was manifested in unirrigated control (0.20) at harvest. Maximum TSS (16.92%) was recorded in the treatment control, followed by 4 and 6 irrigations at an interval of 10 days. Plants irrigated 6 times at an interval of 10 days resulted in maximum number of fruits (175.3) per plant compared to the minimum in control (40.2).

Field validation trial of icm technologies during 2016 at charghat (Rajshahi), Natore, Mujibnagar (Meherpur) and Chuadanga for reducing flower and fruit dropping in mango

Large-scale farm level field validation trial as well as small scale up scaling of developed ICM technologies has been done at the farmers' field of the four major mango growing districts viz. Rajshahi, Natore, Meherpur and Chuadanga of Bangladesh under KGF funded project "Sustainable Management of Flower and Fruit Dropping of Mango". Under ICM packages very much promising results viz. 33.07, 29.22, 23.93 and 21.45% increased yield were recorded at Charghat (Rajshahi), Natore, Mujibnagar (Meherpur) and Chuadanga sadar, respectively. This year the average number of fruits per plant under ICM packages was also recorded higher than that of Non-ICM packages in the four mango growing districts and it was recorded 337.2, 309.1, 1186 and 1676 number of fruits/ plant under ICM packages while it was recorded 253.4, 239.2, 957 and 1380 number of fruits/ plant under Non-ICM packages. The results especially fruit yield from the validation trial of ICM packages at the selected locations were very much satisfactory. So, we will continue the validation trials in a large scale in the selected locations next year.

Effect of fruit bagging on different mango varieties grown at Chapainawabganj

An experiment on fruit bagging on mango was conducted at the Regional Horticulture Research Station, BARI, Chapainawabganj for producing quality mango with minimum application of pesticides. Mangoes are susceptible to different insect-pest and diseases. In this experiment six BARI released and 4 commercial varieties were evaluated in order to improve fruit quality as well as increase the production of exportable mangoes. The fruits were bagged 40 days after fruit set of each variety. Three treatments were used viz., $T_{1:}$ brown colour double layer paper bag, T_2: white color single layer bag and T_3: control (no bagging). Double layer brown colour paper bag changed fruit color to all varieties. In all cases good quality, cleaner, disease and insect free fruits were harvested. These results indicate that fruit bagging can improve fruit quality through reduction in disease and insect-pest attack and shelf life of mango.

Bio-chemical analysis of different mango varieties after fruit bagging

An experiment was conducted at the Regional Horticulture Research Station, BARI, Chapainawabganj and Bangladesh Council of Science and Industrial Research Laboratory to know the bio-chemical composition of each mango variety after fruit bagging. Four mango varieties including two popular BARI released varieties like BARI Aam-3 and 4 and two important commercial varieties such as Fazli and Ashwina. The bio-chemical analyses are being continued upon the harvesting of each variety. Three varieties viz. BARI Aam-3, 4 and Fazli already have sent for analysis. Among these, bio-chemical analysis of BARI Aam-3 has been completed. Bagging mangoes showed excellent shelf life (13 days) compared to control (7 days). TSS of mango with bagging (22%) was higher than that of (21%) mango without bagging. Bagging mango contained 34.31 ug/100 g Vitamin-C since non bagged mango contained 24.17. The vitamin-A (beta carotene) was also higher in bagged mango (4218.07 ug/100 g) than non bagged (3804.34 ug/100 g) mango. Total sugar of bagged mango was higher than than that of non bagged mango. From the physical examination, organoleptic test and laboratory analysis report it was revealed that fruit bagging technology had no negative effect on mango fruit quality. In addition, it prevented the fruits from any kind of pest infestation and diseases infection. It possessed attractive fruit color and exhibited good shelf life which is very important for exportable mango.

Performance of fruit bagging at different location and different varieties on colour development and shelf life of mango

An experiment on fruit bagging was conducted at the Regional Horticulture Research Station, BARI, Chapainawabganj and Mithapukur, Rangpur for producing quality mango with minimum application of pesticides. Mangoes are susceptible to different insect-pest and diseases. In this experiment six BARI released and one commercial variety (Harivanga) were evaluated in order to improve fruit quality as well as increase the production of exportable mangoes. The fruits were bagged 40 days after fruit set of each variety. Three treatments were used viz., $T_{1:}$ brown colour double layer paper bag, $T_{:}$ white color single layer bag and T_3: control (No bag use). Double layer brown colour paper bag changed fruit color to all varieties. In both of the locations, good quality, cleaned, disease and insect free fruits were harvested. These results indicate that fruit bagging can improve fruit quality through reduction in disease and insect-pest attack and shelf life of mango.

Effects of different fertilizers on internal breakdown of BARI aam-3

An experiment was conducted on the effects of fertilizers on jelly seed of mango at the Regional Horticulture Research Station, BARI, Chapai Nawabganj. The plants were fertilized with four treatments vis. T_1: Control (no fertilizer), T_2: 7 kg $(NH_4)_2SO_4$ + 2kg $ZnSO_4$,$T_{3:}$ Recommended dose (Cow dung, Urea, TSP, MOP, Gypsum, ZnSO4 and Boric acid @ 50 kg/tree, 2 kg/tree, 1 kg/tree, 400 g/tree, 500 g/tree,100 g/tree and 50 g/tree) and T_4: 7 kg $(NH_4)_2SO_4$ + 5kg Gypsum, T_5: 9 kg $(NH_4)_2SO_4$ + ½ kg Boric Acid. Highly significant variations were recorded in case of initial fruit setting on 17 March, where T_2 showed maximum (20.47 fruits / panicle) fruit setting and T_1 exhibited minimum (11.40 fruits/ panicle) fruit setting. Maximum number of fruit dropping occurred at first 12 days and then the second highest number of fruit dropping occurred in the next 11 days (22^{th} day). Finally, T_2 exhibited the highest (0.95) number of fruit retention and T_1 resulted in the lowest (.47) number of fruit retention. Maximum TSS was recorded in T_2 and the lowest TSS was recorded in T_1 at all dates of harvest except 21.06.16 and 19.06.16. TSS was comparatively low in ripe harvested mangoes in all the treatments than all other dates of harvest. Shelf life ranged from 7.76 days to 6.95 days, where T_2 exhibited the longest shelf life (7.76 days) and the shortest shelf life was recorded in T_1 (6.95 days). The highest yield (kg per plant) was obtained from T_2 (125.33 kg/ plant) as against the lowest yield in T_1 (21.88 kg/ plant). Mature harvested mangoes were less affected by jelly seed than ripe harvested mangoes. The highest number of jelly seed free mangoes was recorded in T_2 at different stages of harvest. Mangoes of T_2 harvested at 15.06.16 (90 days) exhibited 100% jelly seed free mangoes which was followed by mangoes harvested at 17.06.16 (90.47%, 92 days) and19.06.16 (80.95%, 94 days). On the other hand ripe harvested mangoes exhibited the maximum jelly seed (Slightly and Fully developed) in T_1 (38.10% and 61.90%). Spongy tissue affected mangoes were recorded in T_4 (4.76%) at 19.06.16. The combination of jelly seed and spongy tissue were recorded in T_4 (4.76% and 19.05%) also at 21.06.16 and 23.06.16, respectively. Except T_1, all other treatments performed better. Considering internal breakdown (jelly seed and spongy tissue), edible portion, yield and all other parameters T_2 [7 kg $(NH_4)_2SO_4$ + 2kg $ZnSO_4$] exhibited the best performance among the treatments. To avoid internal breakdown (jelly seed and spongy tissue) fruits should not be harvested at ripe stage from the tree. It may be concluded that fruits should be harvested at 90-94 days after 1^{st} fruit setting and delayed harvest must be avoided.

Effect of NPKS doses on the growth and yield of banana var. Bari kola-3 in hill valley

A field experiment comprising fourteen fertilizer treatment viz., T_1: Native fertility, $T_{2:}$ $N_0P_{80}K_{300}$ S_{36} (g/plant), $T_{3:}$ $N_{115}P_{80}K_{300}$ S_{36} (g/plant), $T_{4:}$ $N_{230}P_{80}K_{300}$ S_{36} (g/plant) [FRG, 2012], $T_{5:}$ $N_{345}P_{90}K_{300}$ S_{36} (g/plant), $T_{6:}$ $N_{230}P_0K_{300}$ S_{36} (g/plant), $T_{7:}$ $N_{230}P_{40}K_{300}$ S_{36} (g/plant), $T_{8:}$ $N_{230}P_{120}K_{300}$ S_{36} (g/plant), $T_{9:}$ $N_{230}P_{80}K_0$ S_{36} (g/plant), $T_{10:}$ $N_{230}P_{80}K_{150}$ S_{36} (g/plant), $T_{11:}$ $N_{230}P_{80}K_{450}$ S_{36} (g/plant), $T_{12:}$ $N_{230}P_{80}K_{300}$ S_0 (g/plant), $T_{13:}$ $N_{230}P_{80}K_{300}$ S_{18} (g/plant), and $T_{14:}$ $N_{230}P_{80}K_{300}$ S_{54} (g/plant) was conducted at the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati Hill district to find out the appropriate dose of fertilizer for better growth and yield of BARI Kola-3 in the hill valley of Chittagong Hill Tracts. Control treatment showed the poor performance in all the parameter. All the parameters showed significant differences among the treatments except plant height, base girth, leaves per plant and TSS(%). Maximum days (416.3 DAT) were required to 1st flowering in case of control treatment whereas minimum days (327.3 DAT) were required to T_7 treatment. Maximum Individual bunch weight (9.1 kg) was found T_7 treatment whereas lightest bunch (6.4 kg) was in control treatment. The highest yield (47 t/ha) was obtained from the treatment T_7 followed by T_5 (44.3 t/ha) and the lowest yield (33.5 t/ha) was noticed from the treatment T_1 followed by T_2 (34.8).

Effects of bagging on different litchi germplasm

An experiment on the effects of bagging on 4 litchi varieties was carried out in the Fruit Research Farm of Horticulture Research Centre (HRC), BARI, Gazipur. There were two factors in the experiment viz., variety of litchi and bagging materials. Four lithci germplasm namely BARI Litchi-1, BARI Litchi-2, BARI Litchi-3 and BARI Litchi-4 along with 3 bagging materials (cotton, black adhesive-bonded brown paper bag and control) were taken for extending the harvesting period of litchi. Varieties of litchi and bagging materials alone and in combination influenced the fruit weight, fruit length, pericarp weight, seed weight and aril weight. Harvesting period was extended about 10-12 days. Fruits of BARI Litchi-1 were harvested 3 days earlier and other varieties were harvested 5 days earlier, when the fruits were covered with cotton bag. Black adhesive-bonded brown paper bag (BPB) delayed the harvesting date by 7 days in all the litchi varieties. The highest aril weight (20.08 g) was recorded in BARI Litchi-4 with cotton bag followed by BARI Litchi-4 with black adhesive bonded brown paper bag (18.62 g). The lowest aril weight was obtained from BARI Litchi-2 (7.35 g) with no panicle bagging (control). Overall harvesting period was extended for 10 to 12 days.

Effects of types of pruning on the tree stature and yield of litchi

An experiment on the effect of types of pruning on the tree stature and yield of litchi was conducted at the Fruit Research Station, Rajshahi. The experiment consisted of four types of pruning viz. P_1: Light pruning (fruit harvest with small portion of branch), P_2: Medium pruning (tertiary branch pruning), P_3: Medium hard pruning (Secondary branch pruning), P_4: Hard pruning (Primary branch pruning). One hundred per cent plants of all the treatments were survived. Light pruning (P_1) required minimum days to sprouting (7 days) of new shoots while hard pruning required maximum days (30). Light pruning (P_1) produced flowers of 70 and 65% in 2015 and 2016, respectively while Medium pruning produced 55% flowers in 2016. Medium hard and hard pruning receiving plants didn't produce any flowers and fruits after two years of giving pruning. Only the plants receiving light pruning gave yield (2500 by number) in 2015. In 2016, the plants receiving light pruning produced 2000 fruits per plant while plants receiving medium pruning gave only 500 fruits per plant. The plants of other treatments didn't produce fruits in 2015 and 2016. The findings revealed that incase of litchi plants light pruning is the best for the next year production but when the tree stature will be controlled by given medium to hard pruning, the yield might be affected for two or more than two years. Litchi plants can survive against any type of pruning.

Effects of fertilizers dose with split application and main-season fruit thining on year round guava production

An experiment was carried out to find out the effects of fertilizers dose with split applications and main-season fruit thinning on the year round guava production at Fruit Research Station, Binodpur, Rajshahi. Four doses of fertilizer and its application installments viz. T_1: 100% fertilizers application of recommended dose in two installments, T_2: 100% fertilizers of the recommended dose in three installment, T_3: 200% fertilizers of the recommended dose in two installments and T_4: 200% fertilizers of the recommended dose in three installments and four levels of main-season fruit thinning viz. P_0 : control (no fruit thinning) P_1: 25% fruit thinning P_2: 50% fruit thinning P_3: 75% fruit thinning were assigned in the experiment. Treatments showed variation regarding fruit yield and individual weight in the main season. Higher level of fruit thinning decreased fruit yield in main season but it increased the fruit yield in the out of season Again, higher level of fertilizer dose increased the fruit yield in both the seasons. The plant receiving 200% fertilizers of the recommended dose in three installments and 75% fruit thinning produced significantly the highest yield (16.6 kg/plant) in out of the season and that was statically similar to that of T_4P_2 (200% fertilizers of the recommended dose in three installments and 50% fruit thinning) treatment, which regulated the year round guava production. Fertilizer dose and its application installments and main-season fruit thinning had positive influence on the year round guava production.

Effect of organic and inorganic fertilizers on the yield and quality of malta (var. Bari malta-1)

The experiment was carried out at the research orchard of HRC, RARS, Hathazari, Chittagong. There were seven treatments including control T_7 (RD: Recommended dose: N @ 240 g, P @ 120 g, K @ 120 g, S @ 30 g, Zn @ 10 g and B @ 2 g per plant). Treatment one (T_1) consisted with cowdung 10 kg/plant + RD (chemical fertilizer); treatment two (T_2) comprising cowdung 15 kg/plant + RD (chemical fertilizer); treatment three (T_3) accomplished with cowdung 10 kg/plant + poultry manure @ 10 kg + RD (chemical fertilizer); treatment four (T_4) was cowdung 15 kg/plant + poultry manure @ 15 kg + RD (chemical fertilizer); treatment five (T_5) consisted with cowdung 10 kg/plant + Mustard oil cake @1kg + RD (chemical fertilizer); treatment six accomplished with cowdung 15 kg/plant + Mustard oil cake @2 kg + RD (chemical fertilizer) per plant. All the recommended fertilizer doses were applied in three equal splits during March, May and October (just after harvesting of fruits). The highest number of fruits was observed in T_5 (42) and T_3 (39) and it was recorded the lowest in control T_7 (21). The highest marketable yield per plant was recorded in T_3 (3.6 kg) followed by T_4 (2.8 kg), T_5 (3.3 kg), T_6 (2.9 kg), while it was noted the lowest in T_1 (1.8 kg) and control T_7 (1.9 kg). The highest marketable yield per hectare was manifested in T_3 (5.6 t) which was followed by T_4 (4.3 t), T_5 (5.1 tons), T_6 (4.5 t) as against the lowest yield in T_1 (2.8 t) and control T_7 (3.0 t). The percentage of edible portion ranged from 74.5 to 76.1 % and TSS varied from 6.5 to 8.0. Considering all the parameter, the treatments T_3 [(cowdung 10kg/plant + poultry manure @ 10kg + RD (chemical fertilizer)] and T_5 [cowdung 10kg/plant + Mustard oil cake @1kg + RD (chemical fertilizer)] were performed better among the treatments.

The effect of different planting time and spacing at strawberry in Norsingdi region

A field experiment was conducted to determine the optimum planting time and plant spacing of strawberry at RHRS, Norsingdi. Three planting dates starting from 15 October 2015 with an interval of 15 days viz.15 October (T_1), 01 November (T_2) and 15 November (T_3) and three plant spacing viz. 15 x 50 cm (S_1), 30 x 50 cm (S_2) and 45 x 50 cm (S_3) were tested on growth and yield of BARI strawberry-1. The highest leaf area 117.04 m^2 and chlorophyll content of leaves (SPAD value) 57.09 was measured in $T_1S_{2,}$ whereas the lowest leaf area and chlorophyll content was manifested in T_2S_3. The highest individual fruit weight (23.47 g), fruit length (5.35 cm) and fruit circumferences (10.32 cm) were found in T_3S_2. Maximum yield per plant (0.71 kg) as well as yield (26.36 t/ha) were obtained from the plants planted on 1st November under 30 x 50 cm spacing (T_1S_2). The lowest yield/plant (0.27 kg) and yield/ha (20.04 t) were recorded from 15th November planting coupled with 45 x 50 cm spacing (T_3S_3).

Disease management

Survey and identification of causal pathogen of brown/black spot of litchi at Rajshahi region

A survey of incidence of brown/black spot of litchi was conducted at Rajshshi region. Incidence of brown/black spot ranged from 6.53-16.21% (average 9.77%) and 1.53-2.71% (average 1.98%) in BARI Litchi-1 and Bombai litchi, respectively. During isolation of pathogen from collected samples pathogen were not found from all samples. *Colletotrichum* sp., *Alternaria* sp. and *Fusarium* sp. were found as a causal agent. Other samples might be sunburn or another cause occurred. So, causal agent of brown/black spot of litchi might be complex.

Survey of citrus diseases

A survey program was conducted on disease incidence of citrus in three locations like HRC fruit field, Joydebpur; Balaier Char, Sherpur; Shibpur, Narsingdi. Among the diseases gummosis was the main problem. The highest gummosis was recorded in Shibpur, Narsingdi with 70% incidence, whereas it was low in Joydebpur and Sherpur with 5-10% and 30% incidence, respectively. The range of Sooty mold was 10-20%, die-back 10-30%, canker 5-15%, scab 5-10% in Joydebpur, Sherpur and Narsingdi.

Collection and identification of straw berry diseases

Disease samples of strawberry were collected from Horticulture fruit research fields, HRC, BARI, Gazipur at different growth stages of strawberry to identify the diseases. Disease symptoms appeared on fruits, leaves, runner and stem were collected and cultured on PDA media. *Fusarium* sp, *Colletotrichum* sp., *Aspergillus* sp., *Penicillium* sp. and *Alternaria* sp. were identified from the leaves and fruits. *Colletotrichum* sp. was identified in runner and fruits. Parasitic nematodes were recorded in roots and rhizosphere soil samples. Most of the diseases were associated with fruits of strawberry. Further survey is necessary for drawing conclusion.

Efficacy of new fungicide in controlling foot rot of betelvine

Two betel vine farmers' 'boroj' infected by foot rot caused by *Sclerotium rolfsii* were selected for test the efficacy of new fungicides at Mohonpur, Rajshahi. There were 5 treatments namely, new fungicides Amistar Top 325 SC (Azoxystrobin + Difenoconazole) (0.05% and 0.1%) was tested under field condition. Bavistin (Carbendazim) (0.1%) in Rajshahi region and Trooper (Tricyclazole) (0.075%) in Barisal region were used as farmer's practices and both were tested in these trials as other treatments with one control. Five sprays were done at ten days interval while the first one was applied after the appearance of disease symptom. In both trials, after 5 sprays, lowest percent mortality was recorded in Amistar Top @ 0.1% treated plot and followed by Amistar Top @ 0.05% treated plot but they were statistically identical. The highest percent mortality was recorded in Control plot followed by Trooper and Bavistin. The highest disease reductions over control in Amistar top @ 0.1% were 96.07% and 94.21% in 1^{st} and 2^{nd} trails, respectively. A trial was also conducted in the previous year (2014-15) in the same area but at different farmers' 'boroj' and found same trend of results. Betelvine is a chewing material and that is why finally lower dose (Amistar Top @ 0.05%) of fungicide might be suggested for farmers in controlling foot rot of betelvine. From two years trials with different fungicides at three farmers' field in Mohonpur, Rajshahi it was concluded that Amistar top 325 SC (0.05%) effectively controlled the vine rot disease of betel vine while 5 sprays were done at ten days interval.

Insect-Pest Management

Survey and documentation of major pests of citrus

The survey was carried out in Gazipur, Narsingdi, Jamalpur, Jaintapur, Akbarpur and Panchagorh areas of Bangladesh in Lemon, Lime, Pumello, Sweet orange, Mandarin and Jara lebu orchards to findout the incidence and pest status of different citrus insect pests. Results revealed that almost same type of citrus pests were found in all survey areas without little exception. The insect Giant mealybug was found only in Panchagorh area possessing major pest status (11.00%) but not in other areas. Psyllid bug was found only in Jaintiapur and the incidence was very high (40.50). Again, Leaf eating weevil was noticed only in Jamalpur and Gazipur and its incidence was very high in Jamalpur (13.50%) and lower in Gazipur (5.50%). Incidence of Leafminer ranged from 14.50% to 24.50%), flower thrips (7.50% to 12.50%) and mite (5.50% to 13.50%) possessed them as major pest status in every location. On the other hand, sapling/seedlings were seriously infested with leaf miners in all nurseries. From the results, it could be concluded that Leaf miner, flower thrips and mite were found as the most serious pest of citrus in every location. Therefore, proper management should be taken against these insect pests.

Development of management strategy (ies) for citrus flat mite infestation in jara lemon

The experiment was conducted in Jara lemon orchards of Farmer at Shibpur upazila under Norsingdi district with the supervision of Regional Horticultural Research station, Bangladesh Agricultural Research Institute, shibpur, Norsingdi to findout the best control measures for managing flat mite. Total eight treatments viz, T_1: Clean cultivation (cleaning of debris, dead branches, etc. just after harvest), $T_{2:}$ Abamectin (Vertimec 1.8 EC) @ 1.2 ml/L water 3 times (at before flowering, after completion of fruit setting and at marble size), $T_{3:}$ McVit 80DF@ 2 g/L water 3 times (at before flowering, after completion of fruit setting and at marble size), $T_{4:}$ Bioneem plus (Azadirachtin 1 EC) @ 1 ml/litre of water 3 times (at before flowering, after completion of fruit setting and at marble size), $T_{5:}$ T_1+ Alternate spraying of Vertimec 1.8 EC and McVit 80 DF@ 2 g/L for 2- times at before flowering and after completion of fruit setting, $T_{6:}$ T_1 + Alternate spraying of Vertimec 1.8 EC and Bioneem plus (Azadirachtin 1 EC) @ 1 ml/litre of water for 2- times at before flowering and after completion of fruit setting and $T_{7:}$ Untreated control were evaluated against flat mite following RCB design with three replications. Results showed that T_5 (Clean cultivation+ Alternate spraying of Vertimec 1.8 EC @ 1ml /L and McVit 80 DF@ 2 g/L for 2- times at before flowering and after completion of fruit setting) treated plants showed the best performance in reducing flat mite infestation and increasing marketable yield. But T_4 (Bioneem plus (Azadirachtin 1 EC) @ 1 ml/litre of water 3 times (at before flowering, after completion of fruit setting and at marble size) treated plants showed the highest marginal benefit cost ratio.

Suceptibility of different varieties of litchi to litchi mite (*Aceria litchi* keifer)

An experiment was conducted at Fruit research station,BARI, Binodpur, Rajshahi on nine varieties/cultivars of litchi viz Bombai, BARI Litchi-1, China-3, Bedena, Dinajpuri, Mojaffarpuri, Green, Madrajee, and BAU litchi-1 on the incident of litchi mite (*Aceria litchi*), its extent of damage to litchi leaves and inflorescence. The highest infestation of 14.87% leaves was recorded in Bombai litchi which was identical to Green, BAU Litchi-1, BARI Litchi-1, Bedena, China-3 and followed by Mojaffarpuri and the lowest 4.24% infestation was noticed in Dinajpuri. Among the tested varieties almost all varieties/cultivars were susceptible to litchi mite. But Dinajpuri variety showed least infestation (4.24%).

Efficacy of different control measures against litchi mite (*Aceria litchi* keifer)

The experiment was conducted at the Fruit research station, Binodpur, Rajshahi to know Litchi mite (*Aceria litchi*), its extent of damage to litchi leaves and inflorescence and the effectiveness of different management practice for controlling litchi mite. There were five treatments viz. T_1 : Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /l of water in February before opening flower) T_2 : Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of wettable Sulphur (Thiovit 80 WP @ 2 g/l of water in February before opening flower) T_3 : Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of Dimethoate 40 EC (Tafgor 40 EC @ 2 ml/l of water in February before opening flower) T_4 : Two pruning of infested foliage 1st on june after harvesting fruits and 2nd on August, T_5 : Untreated control. The lowest leaf infestation (4.87 %) was observed in T_1 : pruning of infested foliage + one spray of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5ml /liter of water) with 86.11% infestation reduction over control which is statistically different from other treatments. The highest leaf infestation (35.07 %) was observed in T_5 (Untreated control). In other other treatments, per cent leaf infestation ranged from 7.39 – 12.85 with 63.35-78.92% infestation reduction. In case of per cent infested inflorescence, the lowest infested inflorescence (2.92 %) was also observed in T_1 with 71.26 % infestation reduction over control followed by T_2 (3.70 %) and T_3 (4.01 %). The highest value of per cent infested inflorescence was observed in T_5 (10.16 %), which differed statistically from other treatments. The number of fruits was maximum in treatment T_1 (920000/ha) and the lowest in the treatment T_5 (506000/ha). The highest gross margin was noticed in T_1 (1869560) and the lowest gross margin was noted in T_5 (1113200). The highest MBCR was manifested in treatment T_2 (5.20) and the lowest in T_4 (3.67).

Efficacy of different types of bagging for management of oriental fruit fly (*Bactrocera dorsalis)* attacking guava

A research work on the fruit fly (*Bactrocera dorsalis*) of guava was conducted at the Fruit Research Station, BARI, Binodpur, Rajshahi to know the incidence, nature and extent of damage and effect of different control measures. Five trees (5 years old) served as a replicate. The varieties BARI Payara-2 was used in this experiment. There were 5 treatments viz. T_1 : Bagging by polythene bag (Perforated), T_2 : Bagging by butter paper bag (Perforated), T_3 : Bagging by brown paper bag (Perforated), T_4 : Bagging by mosquito net and T_5 : Control (Untreated). The per cent infestation was recorded the highest (93.33%) in the untreated control. The least (0%) infestation was found in the plants treated by all types of bagging except bagging by mosquito net which caused 41.66% infestation. To control the guava fruit fly, all type of bagging showed the best result with 100% infestation reduction over control except bagging by mosquito net (55.36% reduction). The highest gross margin was noticed in T_1

treatment (1269600) and followed by T_2 and $T_{4.}$ The lowest gross margin was observed in T_5 treatment. The highest MBCR was observed in T_1 (4.56) and the lowest was T_4 (0.53).

Survey, collection and identification of different pollinators of mango

A research work on the pollinator of mango was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi to know about the pollinator visited the mango orchard during flowering stage. Six years old of 15 mango (BARI Aam-4) plants were selected to record the data. Individual whole plant was observed and number of different insects were counted ten days continuously, 6 am to 6 pm at one hour interval and averaged. The survey of insect species visiting mango flowers indicated that the highest number of species were from the order Diptera (flies), 4, then Hymenoptera (ants, bees, wasp),1. The insect population (number/100 panicle) was the highest 35.69 of Syrphid fly, in decreasing order of population were Ant (13.08), House fly (7.92), Blowfly (3.62) and Flower fly (2.46). The Syrphid fly was the most efficient pollinator due to its frequent appearance during flowering period. The highest number of insects was observed as a pollinator or visitor at the first half of the day (8 am to 11 am). No fruit was observed in the completely bagged panicle (without pollination).

Survey, collection and identification of different pollinators of litchi

A research work on the pollinator of litchi was conducted at Fruit Research Station, Binodpur, Rajshahi to know about the pollinator visited the litchi orchard during flowering stage. Forty years of litchi trees were selected to record the data. Three varieties of litchi viz BARI litchi-1, Bombai and Dinajpuri were observed and number of different insects were counted as pollinators/visitors. BARI Litchi-1, Bombai and Dinajpuri observed 10 days continuously from 1 to 10 March, 11 to 20 March and 21 to 30 March. The survey of insect species visiting litchi flowers indicated that the highest number of species were from order Diptera (flies), 4, then Hymenoptera (ants, bees, wasp), 1. In BARI litchi-1 the insect population (number/panicle) was the highest 1.15 of Syrphid fly in decreasing order of population were Honey bee (1.03), Flower fly (0.73), Blow fly (0.38) and House fly (0.25). In Bombai litchi, population of Honey bee was the highest of 2.44, in decreasing order of Flower fly (0.76), Srphid fly (0.58), Blow fly (0.10) and House fly (0.05). In Dinajpuri litchi, Honey bee was noted the highest of 2.42, in decreasing order of Syrphid fly (0.46), Flower fly (0.36), Blow fly (0.09) and House fly (0.06). The highest number of insect was observed as a pollinators/visitor at the first half of the day. Five types of insects were recorded as pollinator or visitor on litchi flower during flowering period.

Efficacy of different types of baggs for management of mango fruit fly *Bactrocera dorsalis* attacking mango

A research work on the fruit fly (*Bactrocera dorsalis*) of mango was conducted at the Fruit Research Station, BARI, Binodpur, Rajshahi to know the incidence, nature and extent of damage and effect of different control measures. There were 8 control approaches viz. $T_{1:}$ Bagging by polythen bag (perforated), T_2: Bagging by butter paper bag (Perforated), T_3: Bagging by brown paper bag (Perforated), T_4: Bagging by mosquito net, T_5: Bagging by mosquito net (Bag banded by Bokrom), T_6: Bagging by China brown paper bag, T_7: Bagging by China white paper bag, T_8: Untreated control to evaluate their effectiveness. The per cent infestation was the highest (24.00%) in the untreated control. The least zero per cent infestation was found in the plants treated by all types of bagging except bagging by mosquito net which caused 5.33% infestation. To control the mango fruit fly all types of bagging showed the best results with 100% infestation reduction over control except bagging by mosquito net (77.79% reduction). The highest gross margin was noticed in T_1 (778860) and the lowest in T_8 (661000). The highest MBCR was found in the treatment T_1 (2.29) and the lowest in T_4 (0.78).

Soil and water Management

Effect of urea super granule with different levels of poultry manure and cowdung on the yield and quality of banana

The experiment was conducted at the Horticultural Research Centre, BARI, Joydebpur, Gazipur to study the comparative yield and quality performance of banana as affected by the different levels of USG and organic manures and to develop USG-organic manure based fertilizer recommendation for quality banana production. The experiment was set up in a split-plot two factor randomized complete block design with three replications. In factor A three levels of organic manure as A_1: 3 ton poultry manure ha^{-1} (1.2 kg plant $^{-1}$); A_2: 5 ton poultry manure ha^{-1} (2 kg plant $^{-1}$) and A_3: 5 ton cowdung ha^{-1} (2 kg plant $^{-1}$) and in factor B four levels of chemical N-fertilizer doses as B_1: Recommended dose of N as PU ($N_{230}P_{80}K_{300}S_{36}Zn_{1.6}B_{0.4}$ g $plant^{-1}$); B_2: Recommended dose of N as USG ($N_{230}P_{80}K_{300}S_{36}Zn_{1.6}B_{0.4}$ g $plant^{-1}$); B_3: 85 % recommended dose of N as USG ($N_{195}P_{80}K_{300}S_{36}Zn_{1.6}B_{0.4}$ g $plant^{-1}$); B_4:70 % recommended dose of N as USG ($N_{161}P_{80}K_{300}S_{36}Zn_{1.6}B_{0.4}$ g $plant^{-1}$) were considered as treatments where P K S Zn and B @$P_{80}K_{300}S_{36}Zn_{1.6}B_{0.4}$ g $plant^{-1}$ were used as a blanket dose. From two years study it was found that both yield and quality of banana was significantly influenced by the USG as well as USG with organic manure. USG as well as USG with organic manure could be more productive in relation to normal prilled urea practice for quality banana production. The highest bunch weight (14.48 and 19.47 kg) was found where 5 ton CD with 85% recommended USG (A_3B_3) and the lowest bunch weight (11.30 and 13.07 kg) was found from 3 ton PM ha^{-1} with recommended PU (A_1B_1) and 3 ton PM/ha with 70% recommended USG (A_1B_4) treatment, respectively. Individual finger weight was significantly affected and maximum finger weight (127.2 and 184.5 g) was recorded from 5 ton CD/ha with recommended USG (A_3B_2) and 85% recommended USG (A_3B_3) followed by A_3B_3 and A_3B_2, respectively, for the two years. Maximum banana yield (50.55 and 42.94 t ha^{-1}) was obtained from cow dung @ 5 t ha^{-1} with 85% recommended of N as USG treatment (A_3B_3) followed by 5 ton CD with recommended N as USG (A_3B_2). Therefore, cow dung @ 5 t ha^{-1} with 85% recommended of N as USG (A_3B_3) with other recommended fertilizer doses could be suggested for better yield and quality banana production.

Post-harvest Management

Effect of cutting size on the quality of minimal processed pineapple

The experiment was conducted at Postharvest Technology Section, Horticultural Research Center, Bangladesh Agricultural Research Institute, Gazipur to select suitable cutting size for minimal processed pineapple. The treatments were $T_{1:}$ ¼ th cut of pineapple, $T_{2:\ 1/3}$ rd cut of pineapple, $T_{3:}$ ½ cut of pineapple and $T_{4:}$ Full pineapple. The cultivar 'Giant que' was evaluated in respect of shelf life, %TSS, pH, % total sugar, color and sensory evaluation by using 1% ascorbic acid ½ cut and ¼ th cut of minimal processed pineapple showed better and equal shelf life (15 Days) over full pineapple (12 days) and $_{1/3}$ rd cut of pineapple (09 days). 1% Ascorbic Acid can reduce the color deteriorations, as well as the overall sensory deterioration in fresh-cut pineapples. Cutting size, ½ cut of minimal processed pineapple showed better performance on total soluble solid (12.57 %), total sugar content (29.54 %), on retaining color (L=60.69) and (h^0=107.8) for longer period of 15 days. T_3 scored satisfactory score in the overall sensory properties of fresh-cut pineapples among all the treatments with 15 days of preservation time at refrigerator (4±1^{o}C).

Postharvest quality of lemon influenced by coating, packaging and storage condition

An experiment was conducted to assess the influence of Aloe vera gel coating, modified atmospheric packaging (MAP) and coolbot storage on postharvest quality of seedless lemon. Sorted fruits were washed; fruit surface water was removed and then coated with 100% Aloe vera gel when applicable. After coating, fruit surface was air dried and kept in MAP or crates and stored at ambient condition

(24±3°C and 50±5% RH) or coolbot (12±1°C and 83±3% RH). Weight loss, respiration rate, ethylene production rate, firmness, decay incidence, TSS, pH, ascorbic acid content, and also organoleptic attributes were analyzed periodically during storage. The results revealed that MAP had immense effect on the reduction of the weight loss, shriveling and preserved firmness throughout the storage. Whereas Aloe vera gel coating mainly helps to retain green colour and control disease incidence of lemon in MAP. Coolbot storage is good to preserve all postharvest quality of seedless lemon for longer period of storage. Initial respiration rate of lemon was 22.17mg.kg^{-1}.h^{-1} and it was reduced sharply up to 6th day of storage in all treatment, but reduction rate was high in lemons stored at coolbot. After 18th day of storage, respiration rate was raised again in MAP uncoated lemons stored at ambient condition. Uncoated without MAP lemons stored at ambient condition had lost 58.75% at 6th day of storage while MAP lemon was as firm as initial up to 12th day in both storage conditions. Maximum weight loss occurred in uncoated and without MAP in both storage condition. Whereas MAP lemons coated or uncoated stored at Coolbot (12±1°C) preserved their weight maximum. Around 14% weight loss happened at 6th day of storage in uncoated and without MAP lemons stored at ambient condition (22±3°C). While MAP lemons coated or uncoated stored at Coolbot (12±1°C) lost less that 5% and stored at ambient condition lost around 6% weight loss at 30th day of storage period. At the day of harvest ascorbic acid in seedless lemon was 46.4 mg/100g and it was reduced in all treatments throughout the storage. During storage, lemons without MAP lost it severely. At 6th day of storage the lowest amount (35.5 mg/100g) was retained by the uncoated lemons without MAP stored at ambient condition it was statistically similar of coated lemons without MAP and stored at the same condition. Coated or uncoated lemons with MAP stored at coolbot were good even up to 8 weeks, but the colour was yellow and coated lemons were shinier and fewer lesions were there.

Socio-economic Studies

Study on the status of major fruits cultivation in south and south-western region in bangladesh

The study to understand the status of major fruits cultivation was performed in Barisal district. A total of 36 tree species comprising both fruit and forest tree were identified in the study of Barisal district. Among them, seven trees were forest tree namely mahogany, raintree, bamboo, koroi, chambul, akashmoni, koroi and bohera and rest of the trees is fruit tree namely, mango, arecanut, jackfruit, guava, coconut, lemon, banana, papaya, hog plum, litchi, carambola, pumelo, jamun, wax apple, date plum, palm tree, sapota, olive, ber, aonla, neem, dillenia, cowa, horitoki, Burmese grape, sweet orange, orange and pomegranate. The highest number of farmers (94%) had mahogany tree followed by mango tree (89% farmer), raintree (80%), coconut (69%) and jackfruit (69%). Total number of trees owned by the respondent farmers were found 7245 in which trees in the garden were 4771 (66% of total trees), in homestead 2267 trees (31%) and a very few were found in cropfield and pond 124 (2%) and 83 (1%), respectively. Ttree land ratio is much higher in garden (10.19 trees in one decimal) than homestead (4.27 trees). The number of forest trees were 5103 (70% of total tree) and fruit trees 2146 (30%) though there were 7 types of forest tree as against 29 types of fruit tree. Forest trees preceded fruit trees in terms of year of transplanting. However, the trend of transplanting fruit trees was increasing. Farmers of 69%, 74% and 37% applied fertilizer, irrigation and pesticide, respectively. Farmers of 80% and 23% did pruning and trimming and grading, respectively. Farmers of 69% had the planning to grow more trees in future. Trees to be grown were mahogany, raintree, mango, chambul, litchi, jackfruit, aonla, olive, hog plum, papaya, akashmoni, coconut, guava and lemon. The farmers, on an average, earned maximum cash from mahogany of Tk. 53,667 (27% share of total cash income) followed by raintree Tk. 49,250 (25%), papaya Tk. 40,000 (20%), mango Tk. 20,842 (11%). As expressed by the farmers they need training on controlling of insect infestation, fertilizer management for good yield, improved cultivation method and improvement of the quality of soil. As the farmers had no planning of growing new type of trees in future, it is suggested to take initiative to disseminate new types of trees in the area under study.

8 FLOWER CROPS

Evaluation of chrysanthemum genotypes

Thirty chrysanthemum genotypes with BARI Chrysanthemum-2 as check variety were evaluated at the Floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2015-2016. There were significant variation among the genotype in respect of plant height (35-64 cm), number of flowers per plant (15-75), diameter of flower (2.6-8.5 cm), stalk length (4.2-12.5 cm) and vase life of flowers (5-13 days). Among the genotypes, CM-004, and CM-022 were found superior for cut flower production as well as CM-015, CM-018, CM-019 and CM-021 for pot culture.

Evaluation of gerbera genotypes

Gerbera is one of the most important herbaceous perennial flowers used commercially as cut flower occupying fourth place in the global trade. Recently, gerbera has been introduced in Bangladesh and gaining its demand. Twenty nine genotypes of gerbera along with BARI Gerbera-1 were evaluated that showed wide range of variation for all quantitative and qualitative characters under study. Based on colour, flower number, flower size and vase life, the genotypes GJ-013, GJ-023, GJ-024 and GJ-028 were identified as promising.

Collection, evaluation and maintenance of dahlia genotypes

Dahlia is a tuberous rooted, semi hardy, herbaceous flowering plant belongs to the family Compositae. It has wide range of flower colours and diversified form of flowers that attract large number of garden lovers.Twenty genotypes of dahlia were evaluated at the Floriculture Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2015-2016. Marked variation on different parameters was observed among the genotypes under study. Considering attractive colour, flower number and maximum durability of flower on the plant, DV-002, DV-007 and DV-010 may be recommended for lawn.

Collection, evaluation and maintenance of gladiolus

Gladiolus is a popular flowering plant grown all over the world as well as in Bangladesh due to its elegant appearance and prolonged vase life. The agro-ecological conditions of the country are very much conducive for its cultivation. A study was conducted at Floriculture Field, Horticulture Research Centre, BARI, Joydebpur, Gazipur during the period from November 2015 to May 2016 to find out the performances of nine gladiolus genotype including BARI Gladiolus-1 used as check. It was revealed from the study that GL-002, GL-031 and GL-037 found as promising genotypes for selection on the basis of its flower and corm characters such as attractive colour, early flowering, maximum number of florets, longest spikes and rachis, highest weight of spike, longest flower durability and corm and cormel production.

Evaluation of anthurium genotypes

Nine anthurium genotypes along with BARI Anthurium-1 as check were evaluated at Floriculture Field of HRC, BARI during the year 2015-2016. The study revealed that there was remarkable variation among the genotypes in both qualitative and quantitative traits. Based on flower colour, spathe size, spadix length, flower number and vase life, AA-004 and AA-007 were found promising to go ahead for varietal development.

Collection and maintenance of heliconia

Heliconia is a dwarf plantain like plant belongs to Musaceae family native to South Africa. It is grown both for cut flowers and for garden or bed decoration purposes. It deserves special importance due to easy culture, wide adaptability to soil and climate, summer production and less prone to disease and pests. Recently, the demand of this flowering plant is increasing due to its attractive colour, prolonged shelf life and economic value. A study on the performance of six heliconia germplasm was conducted at Floriculture Farm of HRC, BARI, Gazipur during 2015-2016. Wide range of variations for all qualitative and quantitative characters was observed. Based on flower colour, errect habit, shoot number and vase life, H-004, H-005 and H-007 were identified as good genotypes.

Collection, evaluation and maintenance of cactus

Cactus belongs to the family Cactaceae and it is suitable for growing in pots for indoor decoration. Cactus cultivation has become a fascinating hobby among amateur gardeners and these desert plants which are mostly unknown have become the subject of greatest care and delicate handling. Despite of their numerous thorns and spines, they have a beauty of their own. Their hardy nature and easy cultivation in shallow soils are additional features for their popularity. Therefore, twenty nine cactus genotypes were collected and maintained at the Floriculture Farm of HRC, BARI, Gazipur. Wide variation in respect of vegetative and floral traits was observed among the genotypes.

Collection and evaluation of euphorbia

Euphorbia is an ornamental flowering plant, belonging to the family Euphorbiaceae. Ten genotypes of euphorbia were evaluated which showed wide variations for all qualitative and quantitative characters. Based on flower colour, flower number, stalk length, large flower size and extended flowering duration, the genotype E-001, E-006 and E-007 were identified as promising genotype for pot culture.

Collection and maintenance of rose

Rose belongs to the family Rosaceae, is one of the natures beautiful creations and is universally known as the Queen of Flowers. Rose is a symbol of love, adoration and innocence. It may be used for planting in beds, borders, as ground covers, growing in pots and for cut flower production. Roses are also grown for their multiple uses like production of petals, extraction of perfumes, for medicinal uses and for sale as cut flowers. At present, it has become the most important commercial flower. It can be grown in Bangladesh for easy cultivation and wider adaptability. Therefore, ten genotypes were collected and maintained at the Floriculture Farm of HRC, BARI, Gazipur. Variation was observed among genotypes in respect of vegetative and foral triats.

Evaluation of aster genotypes

China aster is a popular annual flower grown around Bangladesh either for cutflowers or flower beds as well as landscape gardening. A study on the performance of five aster genotypes was conducted at Floriculture Field of HRC, BARI, Gazipur during 2015-2016. Marked variations for all qualitative and quantitative characters were observed. Based on flower colour, flower number, flower size and durability of flower, the genotypes A-001 and A-004 were identified as good genotype.

Collection, evaluation and maintenance of lily

Lily is an ornamental bulbous flowering plant. It has large and showy flowers with many bright colours. It belongs to the family Amaryllidaceae which are suitable for planting in bed, borders, pot, rockery, shrubbery and in landscaping.They are also popular as cutflower because of their large size, attractive colour and good keeping quality. It can be grown in Bangladesh for easy cultivation technique and wider adaptability.Seventeen genotypes of lily were evaluated at the Floriculture Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2015-2016. Significant variation on different parameters was observed among the genotypes under study. Based on flower colour, flower size, stalk length and flower durability, L-017 were identified as good genotype.

Studies on variabilities of local dendrobium orchids

An investigation was carried out to find variability and identify morphological characteristics of 15 local Dendrobium orchid germplasm at the Orchidarium of Floriculture Division, HRC, BARI at Joydebpur, Gazipur during the period 2015-2016. The results indicated the existence of wide variability among the genotypes on their physio-morphological characters along with yield and yield attributes. Considering flower colour, flower size, flower number and flower durability, D-001 (*D. formosum*), D-004 (*D. parshii*), D-011 (*D. longicornu*) and D-013 (*D. densiflorum*) may be selected as promising ones.

Collection and conservation of wild flower germplasm

Bangladesh is unique in having diversified wild flower crop genetic resources in a range of habitats. Their elegance nature and wild colours gave them a haunting beauty. Many species, in fact, are widely adapted and found to grow in more than one of these ecological categories. However, these native germplasms are considered threatened due to large-scale destruction of their natural habitat. Therefore, it is needed to collect, characterize and conserve of wild flower germplasm for future research. The experimental material comprised of fourteen genotypes which were collected from across the country and conserved field gene bank of floriculture division of HRC, BARI. Intercultural operations such as weeding, watering, manuring, fertilization, disease pest management etc. were done as and when necessary.

Performance of exotic ornamental gourds lines

Twelve ornamental cucurbit lines were collected and evaluated at the research field of Floriculture Division, Horticulture Research Centre, BARI, during the winter season of 2015-2016 to observe the adaptability as well as yield and storage duration. Wide variability was observed among the lines. The range of number of fruits per plant was 3.0-7.0; fruit weight ranged from 100-600 g. The range of fruit size was 4.5-11.0 cm. Fruit yield varied from 0.5-1.9 kg per plant. Storage duration was good ranging from 150-300 days. Considering attractive fruit shape, skin color and storage condition, all the lines may be used as decorative purposes.

Hybridization in adenium flower

Adenium (*Adenium obesum*) is one of the most important indoor decorative succulent plants in Bangladesh. Breeding of adenium is a fascinating aspect. Different attractive colours, various shapes and large number of florets are demand to the users. So there is a great scope for hybrid varieties in our country. In view of the importance of this crop, hybridization program on adenium was conducted in the flowering season December-January, 2015-2016 at net house of Floriculture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Crossing was done between two adenium genotypes and pods were successfully produced.

Effect of varieties and disbudding on the quality cut flower production of chrysanthemum

The chrysanthemum belongs to the family compositae, is one of the most beautiful flowering plants growing commercially in different parts of the world. Recently this flower is getting importance as cut flower in Bangladesh. Disbudding operation is an important factor in the maintenance of high quality product. In the chrysanthemum production this operation is very much important through which large and long stalked flower may be obtained. It is needed to find out how many flowers should be allowed to retain in the plants for specific varieties. Therefore, an experiment was conducted at the Floriculture Research Field of Horticulture Research Centre, BARI, Gazipur during 2015-2016 to study the effect of varieties and disbudding to produce quality cut flower of chrysanthemum varieties. Longest flower stalk length was found in standard white and maximum diameter of flower was obtained in standard yellow. Disbudding had also significant influence in stalk length and flower diameter. The highest stalk length and flower diameter were achieved under allowing 4bloom/plant.

Cultivation of gerbera under protective condition

Gerbera (*Gerbera jamesonii* Bolus) is a popular commercial flower, occupying fourth place among cut-flowers, in the global trade. It is considerable demand in both domestic and export markets. It is one of the top ten cut flowers of the world flower trade which ranks fifth in the international flower trade. Though the crop can be cultivated in moderately warmer areas in the open sunny conditions, the performance of the crop is enhanced when grown in protected or semi-protected structures. The main advantage of growing in the crop under cover or protected conditions is exploitation of genetic potential of the genotypes and crops can be cultivated successfully throughout the year. Therefore, the study of protective condition on gerbera was undertaken at Floriculture Division, HRC, BARI, Gazipur during 2015-2016. One month old of tissue cultured BARI Gerbera-1 was included in this study with protective structures (poly tunnel and polyvinyl house) including control (open field). Maximum growth, yield and quality of gerbera flower were recorded in polyvinyl house.

Influence of maturity stages on seed quality of China aster

China aster (*Callistephus chinensis* L.) is a popular annual flower grown around Bangladesh either for cut flowers in arrangements or flower beds as well as landscape gardening. To increase the adequate supply of this flower in the market it is necessary to have adequate availability of good quality seeds in the growing season. Seed quality plays an important role in the production of agronomic and horticultural crops. Similarly seed quality of China aster depends on many factors and one of the major factors is the optimum harvesting stage of seeds. Optimum harvesting stage of seeds influences the seed moisture content, seed maturity, germination, seedling health and finally the flower production of China aster. Therefore, a study was conducted at Floriculture Research Field of HRC, BARI during the winter season of 2015-16 to find out the optimum maturity stages of China aster seed. Two genotypes A_1 and A_2 (standard white and standard pink) and 6 maturity stages viz. 21, 28, 35, 42, 49 and 56 DAF (days after flowering) were included in this study. Among the genotypes A_2 responded better in seed quality parameters and 42 DAF was found optimum for harvesting seed for both the genotypes.

Effect of different GA_3 concentration and frequency on growth, flowering and yield of button flower

Button flower (*Gomphrena globosa*) is an important seasonal flower crop of the Asteraceae family and is a native of America. In recent years, idea of regulating plant growth, flower yield and quality by application of plant growth regulators has assumed significant importance. Therefore, the experiment was conducted at the Floriculture field of Horticulture Research Centre, BARI, Gazipur during 2015-2016 to study the response of button flower to gibberellic acid at three different concentrations and frequencies.The experiment comprised of ten treatments, viz., three concentrations of GA_3 (50, 150, 250 ppm) at three frequencies (single, double and triple spray at 30, 45 and 60 days from transplanting) and control. Each treatment was replicated thrice in randomized complete block design. Among the different treatments, GA_3 250 ppm single spray recorded maximum plant height (42.5 cm), plant spread and number of branches (15.0) per plant. Longest flowering duration (60.0 days), maximum flower diameter (0.5 cm), maximum shelf-life (65.0 h) as well as highest yield (15 t/ha) were also recorded in this treatment.

Effect of varieties and planting materials on flowering and bulb production in tuberose

An experiment was conducted at the Floriculture Research Field of HRC, BARI, Gazipur during April, 2015 to March, 2016 to find out the suitable planting materials for specific tuberose genotype for flowering and bulb production of tuberose. Individually both genotypes showed better performances for some specific parameters and large bulb showed best results among different planting materialss. There were no significant variations among the various combination of tuberose varieties and planting materials on growth and flowering of tuberose.

Effect of growth regulators on growth, flowering and corm production of gladiolus

Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers due to its flower spikes with florets of massive form, brilliant colours, attractive shapes, varying size and excellent shelf life. An experiment was carried out to study the effect of growth regulators on growth, flowering and corm production of gladiolus during 2015-16 at floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. Four growth regulators viz., GA_3, BAP, CCC and MH each at two concentrations and water as control comprised nine treatments of this experiment. The experiment was laid out in a Randomized Complete Block (RCB) Design with three replication. All the growth and yield parameters were periodically observed. The results revealed that the growth regulators application significantly influenced the growtrh and yield of gladiolus. The maximum number of florets/spike, spike length, rachis length, floret number and flower yield were obtained with GA_3 @ 200 ppm as compared to rest of the treatments. Whereas CCC @ 500 ppm was found the best interms of corm and cormel production.

Effect of organic amendments and bio-control agent on flowering and corm production of gladiolus

Gladiolus belonging to the family Iridaceae, is one of the most popular cut flower in Bangladesh. An experiment was conducted at Floriculture Division of Horticulture Research Centre, BARI, Gazipur, during November 2015 to May 2016 to study the influence of different organic amendment and bio-control agent on flowering and corm production in gladiolus. Significant increase in floret number, spike length, rachis length, spike number, flower durability, corm and cormel production were recorded in gladiolus with application of Tricho-compost (3 t/ha) + ¼ RDF in soil. The control treatment which included recommended doses of fertilizers performed poor in respect of flower, corm and cormel production.

Standardization of EC in nutrient solution on yield of marigold

The experiment was carried out at the glass house of Horticulture Research Centre, BARI, Joydebpur, Gazipur, during November 2015 to April 2016. The study was set up in CRD with three replications. Marigold 'Inca' was used as material. Five different level of EC (T_1= 0.5 ds/m, T_2= 1.0 ds/m, T_3=1.5 ds/m, T_4= 2.0 ds/m and T_5= 2.5 ds/m) and pH (6.0) were maintained. The seedlings of 25 days were grown on bucket containing marigold nutrient solution. Seedling of marigold was transplanted on November 2015.The study revealed that there was remarkable variation observed among the electrical conductivity level. However, electrical conductivity level 1.5 ds/m performed best in respect of plant and floral character of marigold.

Adaptive trial of gladiolus varieties at farmers field

The aesthetic value of flowers in the daily life is increasing with the advancement of civilization. Gladiolus is used as cut flower in Bangladesh. The major production belts of this flower in the country are Jessore sadar, Sharsha, Chowgacha, Kushtia, Chuadanga, Satkhira, Khulna, Chittagong, Mymensingh, Dhaka, Savar and Gazipur regions. Now a days, farmers are cultivating different cultivars of gladiolus in different locations. However, yield potential of those cultivars is not known and some of them are not performing well in our country. BARI has developed 5 varieties of gladiolus which have high potential in yield and other characters but these varieties are not widely cultivated in Bangladesh. Therefore, quick dissemination and popularization of BARI released gladiolus variety is urgently needed. Widespread and effective demonstration of them at farmers' field will lead to ensure availability of gladiolus flowers in Bangladesh. A trial was conducted at Sreepur (Gazipur), Sonatola (Bogra), Godagari (Rajshahi), Godkhali (Jessore) and Bodorgonj (Rangpur) during Rabi, 2015-2016 to evaluate the performance of gladiolus varieties and to popularize among the farmers. The experiment was laid out in RCB design with four dispersed replications. The unit plot was 500 m^2 areas with plant spacing of 20 × 20 cm. Four varieties of gladiolus viz. BARI Gladiolus-1 (Red), BARI Gladiolus-3 (White), BARI Gladiolus-4 (Pink) and BARI Gladiolus-5 (Yellow) were included in the trial. The field was well prepared by adding 10 t cowdung and fertilized @ 200 Kg N, 50 Kg P, 150 Kg K, 20 Kg S, 2 kg B and 3 kg Zn /ha. Cowdung, P, K, B, S and Zn were applied as basal and N was top-dressed in two equal splits at 4 leaf stage and spike initiation stage.Intercultural operations were done as and when necessary. Pest and other crop management practices were done as and when necessary. The spikes were cut when lower 2-3 florets showed their blushes of colour. The data on yield and yield contributing characters were taken and analyzed statistically and means were separated by LSD test at 5% level of significance. The gross economic return was calculated on the basis of prevailing market price of the commodities.All the varieties like BARI Gladiolus-3, BARI Gladiolus-4 and BARI Gladiolus-5 showed better performance and produced higher yield at all locations than BARI Gladiolus-1. The demand of BARI Gladiolus-3 and BARI Gladiolus-5 was more in Gazipur, Rajshahi and Bogra depending on the consumer's choice, early flowering and economic value. But the demand of BARI Gladiolus-3 and BARI Gladiolus-4 were more in Rangpur and Jessore.

9 AGRONOMY

Crop Management

Yield of winter chili as affected by seedling age and number of seedling per hill

The experiment on winter chili was carried out at Joydebpur, RARS, Jamalpur and RARS, Rahmatpur of Bangladesh Agriculture Research Institute during rabi season of 2015-2016. The experiment was laid out in a randomized complete block design with two factors. Factor 1= Seedling age (25, 30 and 35 days) and Factor 2 = No. of seedling hill^{-1} (1, 2 and 3). It comprised of 9 treatment combinations viz. D_1S_1=25 days aged seedling + 1 seedling hill^{-1}, D_1S_2=25 days aged seedling + 2 seedling hill^{-1}, D_1S_3=25 days aged seedling + 3 seedling hill^{-1}, D_2S_1=30 days aged seedling + 1 seedling hill^{-1}, D_2S_2=30 days aged seedling + 2 seedling hill^{-1}, D_2S_3=30 days aged seedling + 3 seedling hill^{-1}, D_3S_1=35 days aged seedling + 1 seedling hill^{-1}, D_3S_2=35 days aged seedling + 2 seedling hill^{-1}, D_3S_3=35 days aged seedling + 3 seedling hill^{-1}. The variety used Manikgonj local at Joydebpur and Rahmatpur and BARI Morich-1 at Jamalpur. Line sowing (50 cm × 40 cm) was done just after the final land preparation and fertilization (120-80-120-20-4 Kg/ha of N-P-K-S-Zn). Different aged seedling (25, 30 and 35 days) of chili was transplanted in the field on 16 November 2015 at Joydebpur and Rahmatpur and on 18 November 2015 at Jamalpur. All fertilizers except nitrogen were applied during final land preparation. Nitrogen fertilizer was applied in three equal split at 25, 50 and 70 days after transplanting. The experiment was conducted under irrigated condition. The highest fruit yield of 9.97, 9.00 and 7.41 t ha^{-1} were obtained from 25 days aged seedling with 2 seedlings hill^{-1} at Joydebpur, 35 days aged seedling with 1 seedling hill^{-1} at Jamalpur and 30 days aged seedling with 2 seedlings hill $^{-1}$ at Rahamatpur, respectively. Maximum net return and BCR of Tk. 228781 ha^{-1} and 4.25 were recorded in 25 days aged seedling with 2 seedlings hill^{-1} at Joydebpur, Tk 122000 ha^{-1} and 3.10 in 35 days aged seedling with 1 seedling hill^{-1} at Jamalpur and Tk 164800 ha^{-1} and 3.87 from 25 days aged seedling with 2 seedlings hill^{-1} at Rahamatpur, respectively. It might be concluded that 25 days aged 2 seedlings hill^{-1} at Joydebpur and Rahmatpur and 35 days aged 1 seedling hill^{-1} at Jamalpur performed better for higher green chili fruit yield and economic return.

Effect of irrigation interval on the bulb yield and storability of garlic

The experiment was conducted at Joydebpur and RARS, Ishurdi research farm of Bangladesh Agricultural Research Institute during rabi season of 2015-2016 to make an appropriate irrigation schedule for optimum bulb yield and subsequent effect on storability of garlic. The experiment was laid out in a RCB design with three replications. The treatments consisted of four irrigation schedule viz; I_1= Irrigation at 10 days interval, I_2= Irrigation at 15 days interval, I_3= Irrigation at 20 days interval and I_4= Irrigation at 25 days interval. Irrigation was applied by following schedule and it was maintained up to the field capacity level. The soil was clay loam in texture having field capacity of 27.5 at Joydebpur and 29.2 percent at Ishurdi by weight and bulk density was 1.50 g/cc at Joydebpur and 1.39 g/cc at Ishurdi. The variety BARI Rashun -2 was used in the trial. Two irrigations were applied just after clove planting and at 30 days after planting for stand establishment of the crop. The crop received 31.0 mm rainfall at Joydebpur and 85.33mm at Ishurdi during its growing period. The increased number of days between irrigation intervals affected bulb yield and yield contributing characters. The highest bulb yield (7.33 t ha^{-1} at Joydebpur and 8.91 t ha^{-1} at Ishurdi) was obtained from 10 days interval irrigation which was followed by 15 days interval (6.28 t ha^{-1} at Joydebpur and

7.71 t ha^{-1} at Ishurdi). In storage, bulb weight loss was more in short irrigation interval than long interval. The loss was maximum in first month than second month. The highest gross return (Tk. 733000 ha^{-1} at Joydebpur and Tk. 891000 ha^{-1} at Ishurdi), gross margin (Tk. 464094 ha^{-1} at Joydebpur and Tk. 622094 ha^{-1} at Ishurdi) and BCR (2.73 at Joydebpur and 3.31 at Ishurdi) were obtained from 10 days irrigation interval followed by 15 days irrigation interval. On economic point of view, farmers can take irrigation schedules of 10 days or 15-days interval for maximum return.

Performance of hyrid maize after t.aman rice under zero tillage-soil mulch condition at ishurdi region

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2015-2016 to find out suitable variety of hybrid maize under zero tillage-soil mulch condition and to reduce cost of production. Five BARI hybrid maize varieties (BHM-3, BHM-5, BHM-6, BHM-7 and BHM-9) BARI Hybrid maize-3, BARI Hybrid maize-5, BARI Hybrid maize-6, BARI Hybrid maize-7 and BARI Hybrid maize-9 were included in the experiment. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown by dibbling manually just after harvest of T-aman rice. The crop was sown on 3 January 2016 (just after harvest of T-*aman* rice) and harvest on 26 May 2016. Fertilizer was applied @ 254-52-110-47-5-1kg/ha of N-P-K-S-Zn-B. One third nitrogen and full amount of other fertilizer was applied as basal before dibbling of maize. Rest of the nitrogen was top dressed in two equal split at 30 and 60 days after emergence. Four irrigations were applied at 30, 60, 90 and 120 days after sowing, respectively. Soil mulching was done at 35 DAS with spade. The highest maize grain yield was obtained from BHM-9 (5.87 t/ha) and BHM-7(4.68 t/ha) but the lowest grain yield was obtained from BHM-3 (3.35 t/ha). Lower grain was harvested in this year due to storm in March 2016.

Performance of BARI released pulses as fodder in between T. *aman* and Boro rice

An experiment was conducted during the *rabi* 2015-16 to evaluate the performance of BARI released pulse crops to be used as fodder. The crops were tested to determine the actual time space to accommodate a fodder crop in T.*aman*-Fodder- Boro rice cropping pattern in relation to their flower initiation, green mass and nutritional and market value. The BARI released fodder crops viz. BARI Felon-1, BARI Motor-1 and BARI Khesari-4 were selected as variety. Seeds were sown in "*joe"* condition in broadcast method and other intercultural operations *viz.* weeding, rouging etc. were done in time. The crude protein percentage of different fodder pulses were calculated by the following formula: % Nitrogen × 5.3 (Conversion coefficient) = % Crude protein. The nitrogen content was higher in BARI Kheshari-4 (4.48%) followed by BARI Motor-1(4.34%). The macronutrient content is more or less within the range in case of potassium (1.19 to 1.21 %), phosphorus (0.33 to 0.41), calcium (2.91 to 3.02%) and magnesium (1.66 to 1.71%). BARI Khesari-4 has the highest protein content (23.74%) whereas BARI Motor-1 has 23% and BARI Felon-1 has 18% protein. Among the fodders BARI Motor-1 was found superior to others considering the days to harvesting (67 days), leaf number/stem (53) and green biomass (49 t/ha).

Performance of hybrid maize varieties in *rabi* season

A field experiment was undertaken at Joydebpur, Gazipur; Rajbari, Dinajpur and RARS, Jamalpur Farm of Bangladesh Agricultural Research Institute during rabi season of 2014-2015 and 2015-2016 to find out suitable hybrid maize variety(s) for obtaining maximum yield. Six hybrid maize varieties viz., BARI Hybrid maize-5, BARI Hybrid Maize-7, BARI Hybrid Maize-9, 900M, Miracle and NK-40 were evaluated. The experiment was laid out in randomized complete block design with three replications. Seeds of all hybrid maize varieties were sown on 18 November, 2014 and 20 November, 2015 at Joydebpur, 18 November, 2014 and 12 November, 2015 at Rajbari and 24 November, 2014 and 19 November, 2015 at Jamalpur. Fertilizer dose and application methods were same in all locations both the years. Fertilizers were applied at the rate of 256-76-121-72-5-1 kg ha^{-1} of N-P-K-S-Zn-B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid, respectively. One third of urea and whole amount of other fertilizers were applied as basal. Remaining 2/3rd of urea was top dressed at 30 and 60 days after sowing (DAS). Four irrigations were done at 15, 30, 60 and 90 DAS. Data on yield and yield contributing characters were recorded in all locations and growth parameters like leaf area, dry matter accumulation and were measured at different growth stages at Joydebpur both the years. To record dry matter weight and leaf area, two plants were sampled at 30, 55, 80, 105, 130 DAS and at harvest. Dry weight of the samples was taken after drying at 80^0C in an oven for 72 hours. Leaf area was measured by an automatic leaf area meter (L13100 c, L1COR, USA). GDD was calculated using the following formula:

$$\text{GDD} = \frac{T\max + \text{T}\min}{2} - T\ base$$

Where, T_{max} and T_{min} are daily maximum and minimum temperatures, respectively. T_{base} indicated base temperature. For maize it is 8^0C. GDD can be summed over days to indicate the amount of heat for growth that the crop has received over any period of the growing season (Ahmed *et al*, 2015). The crop was harvested at physiological maturity in all locations both the years. The yield component data was collected from randomly selected five plants prior to harvest from each plot. At harvest, the yield data was recorded plot wise. Data was analyzed statistically and means were compared using LSD test at 5% level of significance in all locations for both the years. Varietal variations showed great influence on dry matter (DM) production, leaf area index (LAI), yield and yield components in all locations. Variety Miracle produced the highest DM and LAI. These parameters finally contributed to higher yield in Miracle, NK-40, 900M and BHM-9 than the other two varieties both the years. Miracle took the longest period (148 DAS with 1950 GDD in 2014-15 and 143 DAS with 2013 GDD in 2015-16 at Joydebpur, 153 DAS with 1927 GDD in 2014-15 and 146 DAS with 1963 GDD in 2015-16 at Rajbari and 145 DAS with 1926 GDD in 2014-15 and 142 DAS with 2119 GDD in 2015-16 at Jamalpur) to attain the physiological maturity and the shortest period was needed by BARI Hybrid maize-5 with lower GDD in all locations both the years. The highest grain yield (12.42 t ha^{-1} in 2014-2015 and 10.11 t ha^{-1} in 2015-2016 at Joydebpur, 12.34 t ha^{-1} in 2014-2015 and 11.39 t ha^{-1} in 2015-2016 at Rajbari and 10.00 t ha^{-1} in 2014-2015 and 14.81 t ha^{-1} in 2015-2016 at Jamalpur) was recorded in Miracle. The results revealed that yield level of Miracle, NK-40, 900M and BARI Hybrid Maize-9 were statistically similar in Joydebpur and Rajbari. Similar trend was observed at Jamalpur. BARI Hybrid Maize-9 might be recommended for taking adaptive program because of low price and availability of its seeds which will reduce dependency on exotic hybrid maize.

Effect of seed priming on the growth and yield of BARI Masur varieties

A field experiment was conducted at Agronomy field, RARS, Rahmatpur, Barisal to evaluate the performance of BARI Masur varieties at different treatments of seed priming. BARI Mosur-1 and BARI Masur-7 were selected as the variety for their small and large sized seed, respectively. Five seed priming treatments viz. control, water priming, water priming + molybdenum, water priming+ boron and water priming+ molybdenum + boron were taken. Treatment did not show significant differences in yield and yield contributing characters. Seed yield was within the range of 796 to 1205 kg ha^{-1} whereas the straw yield was within the range of 1650 to 2333 kg ha^{-1}. Days to maturity was maximum for the treatment combination BARI Masur-7 when primed with molybdenum and boron solution (113 days) and the minimum by the treatment combination BARI Masur-1 when primed with only water.

Effect of herbicide on soil and crop performance of wheat and mungbean

A field experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2015-16 to find out the effect of herbicide on soil properties and crop performance. Seven treatments viz. T_1= Affinity (Carphentazone ethile, 1.5 kg/ha), T_2= U-46 D fluid (3 l/ha), T_3= Glysel (Glyphoset, 3.7 l/ha), T_4= Ronstar (Oxadiazone, 1 l/ha), T_5=Panida (Pandimethalin, 2.5 l ha^{-1}) T_6= Hand weeding and T_7= Control (No weeding) were included in the experiment. Herbicides were applied at pre-emergence condition (seven days before sowing). The experiment was laid out in a randomized complete block design with three replications. The wheat crop was fertilized with 120-30-90-15-2.6-0.6 kg/ha of N-P-K-

S-Zn-B (FRG, 2012). All nutrients including 2/3 of N were applied as basal. Rest 1/3 N was top dressed at CRI stage. BARI Wheat-26 was sown 30 November 2015 and harvested on 22 March 2016. Two times weeding was done on hand weeding treatment at 15 DAS and 30 DAS in wheat. After harvesting of wheat pre emergence herbicides were applied for mungbean. Mungbean was sown in the field at 28 March 2016. But no weeding was done in others treatment. Weed sample was collected from every plot in same place at 20 DAE in wheat and 25 DAE in mungbean. Mungbean was harvested on 28-30 May 2016.The soil properties noticed a negligible change after application of herbicides in soil. In case of wheat field, *Cyperus rotundus* (Mutha), *Cynodon dactylon* (Durba), *Chenopodium album* (Bathua) were found dominant weed species. Among the herbicides, the highest efficiency of weed control was found in Affinity (72.3%) followed by Ronstar (69.1%) in wheat. Hand weeding produced the highest grain yield (3.03t ha^{-1}) and affinity gave higher grain yield (2.81t ha^{-1}) among the herbicides in wheat. Although, hand weeding produced the highest grain yield, on the basis of economic point of view Affinity could be applied for controlling weed in wheat field and Ronstar in mugbean field. Applied herbicide reduced orgamic matter in soil in minute trend.

Effect of herbicide on weed growth and yield of lentil

A field experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2015-16 to find out the suitable herbicide to control weed in lentil field. Twelve treatments viz. T_1= Affinity (Carphentazoneethile, 1.5 kg/ha), T_2= U-46 D fluid (3 l/ha), T_3= Glysel (Glyphoset, 3.7 l/ha), T_4= Ronstar (Oxadiazone, 1 l/ha), T_5=Panida (Pandimethalin, 2.5 l ha^{-1}) T_6=Whipsupr (Fenoxiprop pi-ethayl, 750ml/ha), T_7= Bonmara (2,4-D amaine), T_8=Granite (Penoxasulam, 93.7 ml/ha), T_9=Bimaster (Glyphoset + 2,4-D, 3.5 L/ha), T_{10}=Amaquat (Paraquat, 2.8 l/ha), T_{11}= Hand weeding and T_{12}= Control (No weeding) were included in the experiment. Herbicides were applied as pre-emergence condition at seven days before sowing and post emergence at 20 days after emergence (Activer substitute Glycel). The experiment was laid out in a randomized complete block design with three replications. The sowing date was 20 November 2015 and the crop was harvested on 8 March 2016. Seeds of BARI Masur-7 were used @ 35 kg/ha. In the experimental plots fertilizers @18-24-30-18-2.0-1 N-P-K-S-Zn-B kg/ha was applied during final land preparation (FRG-2012). Weed sample were collected (1 m^2 per each plot) at 25 DAS and weed dry matter was taken after oven dry.Among the herbicides, ronster was effective for achieving higher yield in pre-emergence application of herbicides but application of whipsuper in post emergence was profitable for lentil cultivation on the basis economic parameters. Although, hand weeding produced the highest seed yield, but it was not profitable due to high cost involvement for weeding.

Effect of sowing date and row spacing on coriander

A field experiment was conducted at Joydebpur, Gazipur and at the research field of Spices Research Centre, Shibganj, Bogra during rabi season of 2015-16 to find out the optimum sowing date and row spacing for higher yield of coriander. This was second year experiment. Five sowing date viz. 10 November, 20 November, 30 November, 10 December and 20 December and three plant spacing viz. 15 cm × continuous seeding, 20 cm × continuous seeding and 25 cm × continuous seeding were used as treatments in 2015-2016. The experiment was laid out in randomized complete block design (RCB) with three replications. Fertilizer was applied at the rate of 120-48-80-20-4.5 kg/ha of N-P-K-S-Zn. Half of N and all P, K, S, Zn and cowdung were applied at the time of final land preparation. The remaining N was applied at 30 DAS followed by irrigation. BARI Dhonia-1 used as variety of coriander. The crops were harvested on 3 March 2016, 9 March 2016, 12 March 2016, 16 March 2016 and 20 March 2016 as per sowing date respectively at Joydebpur in the year, 2015-16. From two years observations, all the parameters differed significantly at different sowing dates. In 2014-2015 the maximum seed yield was observed in 10-30 November sowing and in 2015-2016, the maximum seed yield was found in 10-20 November sowing. December sowing showed lowest seed yield in both the years. In this experiment, no significant effect was found on row spacing. Two years results revealed that optimum sowing time for coriander was 10 November to 30 November irrespective of row spacing.

Effect of foliar application of N, ZN and B on growth and yield of tomato

A field experiment was carried out at the research field of Agronomy Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2015-2016 to find out the effect of foliar application of N, Zn and B on fruit size and number and yield of tomato and also to find out the optimum nutrient concentration for maximum yield of tomato. There were eight nutrient concentration viz. T_1= control, T_2= N (0.08%), T_3= Zn (0.05%), T_4= B (0.03 %), T_5= N (0.08%) + Zn (0.05%), T_6= N (0.08%) + B (0.03%), T_7= Zn (0.05%) + B (0.03%) and T_8= N (0.08%) + Zn (0.05%) + B (0.03%) were used as treatment. BARI Tomato-15 was used as variety of this experiment. The experiment was laid out in randomized complete block design (RCB) with three replications. The nutrients were dissolved in tap water for respective concentrations and were applied with knap sack sprayer as a foliar feeding at 15 and 21 days after transplanting. The sources of these nutrients were urea, boric acid and zinc sulphate. The main field was fertilized with cowdung 10 ton/ha and 131-43-37 kg/ha N-P-K respectively (soil test base). Entire TSP, ½ cowdung and ½ MoP were used at final land preparation and rest ½ cowdung was applied during pit preparation. Rest ½ MoP and whole urea were top dressed at three equal installments at 10, 25 and 40 days after transplanting. Seeds were sown on 29 October 2015 in seed bed and transplanted in main field on 1 December 2015. The tallest plant (93.5 cm), the highest number of fruit plant^{-1} (34.43), fruit weight plant^{-1} (2066.67g) and yield (92.59t ha^{-1}) were found in folliar spray of N (0.08%) + Zn (0.05%) + B (0.03%) along with the basal dose 131-43-37 kg/ha N-P-K respectively + cowdung 5 ton/ha.

Phenology, dry matter accumulation and yield of summer onion in relation to planting time

A field experiment was carried out at Agronomy field, Joydebpur, Gazipur and RARS, burirhat, Rangpur, during the *kharif* season of 2015 to find out the optimum planting time for obtained maximum yield and also to study the plant phenology and dry matter partitioning of summer onion. Seven planting date viz. D_1= 1 April, D_2= 1 May, D_3= 1 June, D_4= 1 July, D_5= 1 August, D_6= 1 September and D_7= 1 October were used as treatment. BARI Piaz-5 was used as variety of summer onion. The experiment was laid out in randomized complete block design (RCB) with three replications. Fertilizer was applied at the rate of 84-40-80-40-2.3-1.5 kg/ha of N-P-K-S-Zn-B + cowdung (5 t/ha). Half of N and K and all P, S, Zn, B and cowdung were applied at the time of final land preparation. The remaining N and K were applied at top dressing at 25 and 50 DAT followed by irrigation. The crop was harvested at Joydebpur, on 17 June 2015, 10 July 2015, 3 August 2015, 15 September 2015 and 28 January 2016. Result revealed that, 1 April to 1 May in *kharif*-I and 1 October in *kharif* II gave the better performances in respect of all parameters. The maximum yield was (23.75 t ha^{-1}) obtained from 1st October planting. Summer onion was not possible to cultivate during August-September due to 100% mortality rate.

Effect of twig removing on growth and yield of garden pea

A field experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur during rabi season of 2015-16 to evaluate the effect of twig removing on the yield and yield attributes of gardenpea (var. IPSA Gardenpea-3). Five treatments viz.T_1= control (no removing), T_2=twig removing 5 cm at 25 days after emergence, T_3= twig removing 7.5 cm at 25 days after emergence, T_4= twig removing 10 cm at 25 days after emergence, T_5= twig removing 12.5 cm at 25 days after emergence were used in the study. The experiment was laid out in a randomized complete block design with three replications. Seeds of garden pea were sown on 17 November, 2015. Fertilizers were applied at the rate of 35-20-25-10 kg/ha of N-P-K-S kg/ha (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum. Half of N, whole amount of TSP, MOP and gypsum was applied as basal. Remaining was top-dressed at 35 days after emergence (DAE). The crop was harvested on 4 February 2016. Higher pod yield (8.19 t/ha) was obtained from control (no removing) which was similar to twig removing 5 cm and 7.5 cm from the tip at 25 DAE. Leafy vegetable yield varied among the different treatments. It was maximum (890. 30 kg/ha) when twig removed 12.5 cm at 25 DAE. Highest gross return (Tk130698/ha), net return (Tk104233/ha) and BCR (4.92) was recorded at 7.5 cm at 25 DAE. From this study it could be suggested that twig removing 7.5 cm from tip including branches at 25 DAE might be profitable technique for garden pea production.

Effect of tillage and fertilization method on maize

The experiment was conducted at the Regional Agricultural Research Station, Jessore during rabi season of 2015-16 to evaluate effect of tillage and fertilization method on yield performance of maize under RCA systems. The treatments were five tillage and fertilization methods viz. T_1=Dibbling planting and dibble fertilization (MG of NPK), T_2= Strip till machine seeding and dibble fertilization (MG of NPK), T_3= Strip till machine Seeding and fertilization (MG of NPK), T_4= Strip till machine seeding and fertilization before stripping (MG of NPK) and T_5= Conventional practice. The experiment was laid out in a Randomized Complete Block (RCB) design with three replications. The experimental plots were fertilized with 115-11-55-7.2-1.8-0.26 kg/ha of N-P-K-S-Zn-B through in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and Boric acid. In case of treatment $T_{3,}$ T_4 and $T_{5,}$ half of urea and the total amounts of other fertilizers were applied in the form granular at the time of tillage and sowing. The rest of urea was top dressed on 40 and 60 Days after sowing (DAS). In case of treatment T_1 and $T_{2,}$ whole amount of urea and other fertilizers were applied in the form mega granular at 14 days after emergence (DAE).The maximum number of grains per cob (559.5) was found in dibbling planting and dibble fertilization method. The highest thousand grains weight (310.7 g) was obtained from conventional practice. The lowest thousand grains weight (272.0 g) was obtained from strip till machine seeding and dibble fertilization method. The highest grain yield (7.4 t/ha) was obtained from dibbling planting along dibble fertilization method. The highest gross margin (Tk. 55205/ha) was calculated from dibbling planting with dibble fertilization method.

Effect of seedling age on grain yield of transplanting hybrid maize under different tillage conditions in southern region of Bangladesh

The experiment was conducted at the Regional Agricultural Research Station, Rahmatpur, Barisal during the rabi season of 2015-16 to find out the proper seedling age for transplanting hybrid maize under different tillage conditions for sustaining the yield and economic return. The tillage condition: i) CT = Conventional tillage and ii) ZT = Zero tillage , Seedling age of hybrid maize were i.) Transplant of 7-Day old seedling, ii. 14-Day old seedling, iii. 21-day old seedling, iv. 28-Day old seedling and v. Direct seeding. The experiment was laid out in split plot design with three replications. Tillage condition was assigned in the main plots and the seedling age in the sub-plots. The tillage condition showed significant effects on the days to maturity, days to field duration and plant height. Seeds/seedlings of maize (BARI Hybrid Maize-9) were sown/transplanted on 28 December 2015. Earlier, seedlings of different ages (7-day old, 14-day, 21-day and 28-day old) were raised in the nursery bed accordingly and row to row distance 60 cm and plant to plant distance was 25 cm maintained. Fertilizers were applied in the experiment field at the rate of 255-75-80-52-5-2.0-1.5 kg/ha N-P-K-S-Mg-Zn-B, respectively along with 6 t/ha cowdung (FRG, 2012). One-third N and all other fertilizers were applied as basal dose during final land preparation. The rest N was applied as top dressing in two equal splits after 1st and at 2nd irrigation i.e. at 20-25 DAP and at 35-40 DAP, respectively. The field duration period by the direct seeding was the highest (119.00 days) followed by 7-day old seedling (108 days) but periods in 14-day, 21-day and 28-day old seedlings were 99.17, 87.83 and 78.83 days, respectively. Transplantation of 7-day old seedling produced the highest yield of grain (9.72 t/ha). Direct seeding and 21-day old seedling gave the yields of 8.69 and 8.06 t/ha, respectively. The treatment interactions of tillage condition and seedling age had no significant effects on the plant characters except the plant height. Results revealed that transplant of 14-day old seedling with conventional tillage, and 7-day old seedling under both conventional and zero tillage conditions could be practiced for increasing the yield and profitability of hybrid maize and reducing the turn-around period in southern region of Bangladesh.

Effect of duration of weed competition on the yield of maize in rabi season

A field experiment was conducted at the research farm of Bangladesh Agricultural Research Institute, Joydebpur, during Rabi season of 2015-2016 to find out the critical period of maize-weed competition. The experiment was consisted of 14 treatments viz; no weeding (T_1), no weeding up to 60 DAE (T_2), no weeding up to 50 DAE (T_3), no weeding up to 40 DAE (T_4), no weeding up to 30 DAE (T_5), no weeding up to 20 DAE (T_6), no weeding up to 10 DAE (T_7), weeding up to 60 DAE by 3 times (T_8), weeding up to 50 DAE (T_9), weeding up to 40 DAE (T_{10}), weeding up to 30 DAE (T_{11}), weeding up to 20 DAE (T_{12}), weeding up to 10 DAE (T_{13}) and weed free by 4 times weeding (T_{14}). The experiment was laid out in RCB design with three replications. The unit plot size was 4.2m x 3.0m. The test variety was BARI Hybrid Maize-9. The crop was fertilized with 250, 75, 120, 52 kg/ha of N,P,K,S (FRG, 2012), respectively. Maize seeds were sown at 60 cm x 20 cm spacing on 17 November 2015. Three irrigations were applied, one for ensuring emergence, the others at 30 and 60 DAE. The crop was harvested on 07 April 2016. Rabi maize was infested by twelve kinds of weeds species. Among the species *Echnochloa crusgalli*, *Digitaria sanguinalis* were found as most dominant with summed dominance ratio of 71.05 and 18.11, respectively. No weeding condition upto 10 DAE and 60 DAE produced weed dry matter 258 g/m^2 and 655 g/m^2, respectively. Weed free throughout the period produced 208 g/m^2 weed dry matter. Grain yield of maize was significantly affected by the duration of weedy environment and weeding period. The highest grain yield of 7.79 t/ha was recorded in weed free treatment (T_{14}) and it was identical with the yield (7.46 t/ha) obtained from weeded upto 60 DAE (T_8). It was observed that weedy environment upto 10 DAE (T_7) produced identical yield (6.87 t/ha) with T_8 treatment. Weedy environment upto 20 (T_6) and 30 DAE (T_6) also produced identical yield of 6.42 and 6.30 t/ha, respectively. On the contrary, grain yield of 5.57 t/ha obtained from weedy environment upto 40 DAE (T_4) was significantly lowered than weedy upto 30 DAE (T_3). Weeding upto 10 DAE (T_{13}) also produced significantly lower yield than weeding upto 40 DAE (T_{10}). Therefore, it indicated that critical period of maize-weed competition lies between 30 to 40 DAE of maize growth and weedy environment from10 to 40 DAE was more sensitive than other growth stage

Effect of different herbicides for controlling weeds in maize

A field experiment was conducted at Agronomy research field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during November 2015 to April 2016 to find out the appropriate herbicide for controling weed in maize field. The treatments were: T_1 = Pendilin 33 EC @ 2 ml/L water spraying at 3 DAS, T_2 = Nicosul 4 SC @ 1.5 ml/L water spraying at 3 DAS, T_3 = Ajafa 12.5 EC @ 1.5 ml/L water spraying at 7 DAE, T_4 = CLIO 33.6% @ 0.75 ml/L water spraying at 7 DAE, T_5 = Samodish 70 WP @ 0.75 g/L water spraying at 7 DAE and T_6 = control (no herbicide or hand weeding). It was set up in randomized complete block design with three replications. The crop was fertilized with cowdung 5 t/ha, 250-55-110-40-5-1.5 kg ha^{-1} of N-P-K-S-Zn-B in the form of Urea, TSP, MoP, Gypsum, $ZnSO_4$ and Boric acid, respectively. Seeds of BARI Hybrid maize-9 were sown on 25 November 2015. It was observed that Shama (*Echinochola crusgali*), Helencha (*Enhydra fluetuans*), Gaicha (*Paspalum commergonii*) and Mutha (*Cyperus rotundus*) were the dominant weeds in the maize field. The highest number of weed was recorded in control plot and it was recorded 433 and 351/m^2 at 25 & 50 DAE, respectively. The lowest number of weed was recorded in T_3 treatment. The highest weed dry weight of 147.9 and 130.8 g/m^2 were recorded in control plot at 25 and 50 DAE, respectively. The lowest weed dry weight of 23.7 and 57 g/m^2 were recorded in T_3 at 25 and 50 DAE, respectively. The highest WCE (weed control efficiency) was also found in T_3 treatment (Ajafa 12.5 EC @ 1.5 ml/L water spraying at 7 DAE) and it was 84% and 56% at 25 and 50 DAE, respectively followed by T_4 treatment (CLIO 33.6% @ 0.75 ml/L water spraying at 7 DAE). Number of grains/cob and grain yield of maize were significantly influenced by different weed management treatments. The highest number of grains (513/cob) and grain yield (6.97 t/ha) were obtained from T_3 treatment followed by T_4 treatment. The lowest number of grains (429/cob) and grain yield (5.17 t/ha) were recorded in T_6 treatment. The result revealed that spraying herbicide Ajafa 12.5 EC @ 1.5 ml/L water at 7 DAE would be the most effective to control weeds for obtaining maximum yield in maize.

Weed control methods in sesame

An experiment was conducted at the Regional Agricultural Research Station, Jamalpur during kharif 2016 to find out the suitable weeding methods for controlling weeds in sesame. The experiment consists of five treatments viz; Pre-emergence application of Affinity (T_1), Pre-emergence herbicide application with one hand weeding at 20 DAE (T_2), One hand weeding at 20 DAE (T_3), Two hand weeding each at 20 and 40 DAE (T_4) and weedy as control (T_5). The experiment was set up in RCB Design with three replications. The unit of plot size was 4m × 4m. The sesame variety BARI Til-4 was used as test crop. The crop was fertilized with 58-30-25-20-2 kg ha^{-1} of N-P-K-S-Zn in the form of Urea, triple super phosphate, Muriate of potash, Gypsum, Zinc and Sulphate, respectively. Seeds were sown on 10 February, 2016. Seventeen different weed species belonging to seven families were found in the experimental field. Among weeds, the grasses had three common species of weeds namely bermuda grass, burn yard grass and goicha and cyperaceae had two common species of weeds namely badail and yellow nutsedge. One hand weeding at 20 DAE gave significantly the highest seed yield (510 kg/ha). The highest BCR of 2.33 was also recorded from one hand weeding at 20 DAE.

Growth and yield of BARI Khaibhutta as influenced by spacing and fertilizer management

The experiment was conducted at the research field of at RARS, Burirhat, Rangpur during *rabi* season of 2015-2016. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4 m x 3.6 m. Two plant spacing viz, S_1= 45 cm × 20 cm (1,11,111plants/ha), S_2= 60 cm × 20 cm (83,333 plants/ha) and six fertilizer doses viz, T_1= 120-35-70-40-5-1.5 kg /ha N- P- K- S- Zn and B (BARI recommended dose), T_2= T_1 + 20% N-P-K, T_3= T_1 + 30% N-P-K, T_4= T_1 + 40% N-P-K, T_5= T_1 + 50% N-P-K and T_6 = Native fertilizer nutrient (Control) were used in the study. Seeds of BARI kaibhutta-1 were sown on 15 November 2015. Fertilizers were applied as per treatments. One-third of nitrogen (Urea) and full amount of all other fertilizers like Triple super phosphate (TSP), Muriate of potash (MoP), Zinc sulphate and Boric acid were applied at the time of final land preparation. The remaining N (Urea) was top dressed in two equal splits at 8-10 leaf stage (35 DAS) and tasselling stage (60 DAS) and mixed thoroughly with the soil as soon as possible for better utilization. A light irrigation was given after sowing of seeds for uniform germination. Irrigation and other intercultural operations like-thinning, weeding, and pesticide application were done as and when required. BARI Kaibhutta-1 was harvested on 22 March 2016. Result reveled that plant spacing S_1= 45 cm x 20 cm (1, 11,111 plants/ha) with fertilizer dose F_5 = 180-53-105-40-5-1.5 kg /ha (BARI recommended ferltilizer dose + 50% N- P- K of RF) might be suitable for getting maximum grain yield (6.84 t/ha) and maximum gross return (Tk 171000/ha), gross margin (Tk. 100321/ha) as well as higher BCR (2.42).

Growth and yield of BARI Sweetcorn as influenced by spacing and fertilizer management

The experiment was conducted at the research field of Agronomy Division BARI, Joydebpur, Gazipur and Regional Agricultural Research Station, Jamalpur during rabi season of 2015-2016. The soil of the research area belongs to the Chhiata series under AEZ-28 (Joydebpur, Gazipur) and AEZ-8 (Jamalpur). Joydebpur, Gazipur soil was clay loam with pH 6.1. Soil samples of the experimental plots were collected and analyzed. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4 m x 3.6 m. Two plant spacing viz, S_1= 45 cm × 20 cm (1,11,111plants/ha), S_2= 60 cm × 20 cm (83,333 plants/ha) and six fertilizer doses viz, T_1= 120-35-70-40-5-1.5 kg /ha N- P- K- S- Zn and B (BARI recommended dose), T_2= T_1 + 20% N-P-K, T_3= T_1 + 30% N-P-K, T_4= T_1 + 40% N-P-K, T_5= T_1 + 50% N-P-K and T_6 = Native fertilizer nutrient (Control) were used in the study. Seeds of BARI Sweet corn-1 were sown on 11 November 2015 at Joydebpur and 17 November, 2015 at Jamalpur. Fertilizers were applied as per treatments. One-third of nitrogen (Urea) and full amount of all other fertilizers like Triple super phosphate (TSP), Muriate of potash (MoP), Zinc sulphate and Boric acid were applied at the time of final land preparation. The remaining N (Urea) was top dressed in two equal splits at 8-10 leaf stage (30-35 DAS) and tasselling stage (50-60 DAS) and mixed thoroughly with the soil as soon as possible for better utilization. A light irrigation was given after sowing of seeds for uniform germination. Irrigation and other intercultural operations like-thinning, weeding, and pesticide application were done as and when required. Leaf area measured by an automatic leaf Area Meter (L13200 C, LICOR, USA). For dry matter estimation, 5 plants were sampled at 15 days interval up to maturity at Joydebpur. The collected samples were dried component-wise in an oven at 80^oC for 72 hours. BARI Sweet corn-1 was harvested on 3 March 2016 (114 days after sowing) at Joydebpur and 07 March 2016 (118 days after sowing) at Jamalpur. Result reveled that in both the location (Joydebpur and Jamalpur) plant spacing 45cm x 20 cm (1,11,111 plants/ha) with fertilizer dose 180-53-105-40-5-1.5 kg /ha (BARI recommended fertilizer dose + 50% N- P- K of RF) might be suitable for getting maximum green cob yield (15.38 t/ha at Joudebpur and 10.36 t/ha at Jamalpur) and highest gross return (Tk 203615/ha at Joydebpur and Tk. 124320/ha at Jamalpur), highest gross margin (Tk. 82618/ha at Joydebpur and Tk. 48820/ha at Jamalpur) as well as higher benefit cost ratio (1.68 at Joydebpur and 1.65 at Jamalpur).

Multiple Cropping

Relay mustard with T.*aman* rice under different management at Ishurdi region

A field experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2015-2016 to find out the suitable management practice for improving yield of mustard in rely with T.*aman* rice. Two mustard varieties (BARI Sarisha-11 and BARI Sarisha-14) and three fertilizer management (Recommended nutrient dose at relaying time, Recommended nutrient doze at relaying time + top dress ½ N during 1st irrigation at 20 days after sowing and farmers practices). The recommended nutrient doze was 120-35-45-30-2-2 kg ha^{-1} of N-P-K-S-Zn and B. The experiment was laid out in a randomized complete block design with three replications. BARI Sarisha-11 gave the highest seed yield (1046 kg/ha) with the highest BCR (2.73) from recommended dose at relaying time + top dress ½ N during first irrigation at 20 days after sowing.

Intercropping Indian spinach with hybrid maize under different planting systems

A field experiment was undertaken at Joydebpur, RARS, Jessore and RARS, Ishurdi of Bangladesh Agricultural Research Institute during *Kharif-1* season of 2015 to find out suitable combination of hybrid maize and Indian spinach intercropping system for higher productivity and monetary advantage. Treatments included in the experiment were: T_1 = Hybrid maize normal row (75 cm × 20 cm) + 1 row Indian spinach (75 cm × 25 cm), T_2 = Hybrid maize paired row (37.5 cm/150 cm × 20 cm) + 1 row Indian spinach (75 cm × 25 cm), T_3 = Hybrid maize paired row (37.5 cm/150 cm × 20 cm) + 2 rows Indian spinach (50 cm × 25 cm), T_4 = Hybrid maize paired row (37.5 cm/150 cm × 20 cm) + 3 rows Indian spinach (37.5 cm × 25 cm), T_5 = Sole maize (75 cm × 20 cm) and T_6 = Sole Indian spinach (40 cm × 25 cm). The experiment was laid out in randomized complete block design with three replications. BARI Hybrid maize-9 was used in all locations and Indian spinach was BARI Indian Spinach-2 at Joydebpur and Ishurdi but local Indian spinach was used at Jessore. Hybrid maize seeds were sown on 15 March, 2015 and Indian spinach seedlings (25 days old) were transplanted on 13 March, 2015 at Joydebpur, at Jessore hybrid maize seeds were sown on 11 April, 2015 and Indian spinach seedlings (20-25 days old) were transplanted on 9 April, 2015. But at Ishurdi, maize seeds were sown and Indian spinach seedlings were transplanted on the same day (4 April, 2015). The seeds of BARI Hybrid Maize-9 were treated with provex at the rate of 3 g per one kg of seed in all locations. Fertilizers were applied at the rate of 250-76-121-72-5-1 kg ha^{-1} of N, P, K, S, Zn, B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid for sole maize and intercrop. One third of urea and whole amount of other fertilizers were applied as basal. Remaining 2/3rd of urea was top dressed at 20 and 40 days after sowing (DAS) of maize. In intercrop, extra N (40 kg ha^{-1}) was applied in 2 splits at 20 and 40 DAT as ring method to Indian spinach. Sole Indian spinach was fertilized at the rate of 70-15-45-15 kg ha^{-1} of N, P, K, S. One third of urea and all other fertilizers were applied as basal. Rest urea was applied in 2 splits at 20 and 40 DAT as ring method in all locations. Light availability was measured by PAR Ceptometer (Model – LP-80, Accu PAR, Decagon, USA) at only Joydebpur location. Data on yield contributing characters were taken from randomly selected 5 plants from each plot. Yields of both the crops were taken from whole plot area. Maize was harvested on 7 July 2015 (116 DAS) and Indian spinach was harvested 6 times on 2 May, 12 May, 20 May, 30 May, 8 June and 18 June 2015 at Joydebpur. On the other hand, maize was harvested on 20 July, 2015 at Jessore and 13 August, 2015 at Ishurdi. Indian spinach was harvest only two times (29 May, 2015 and 30 June, 2015) at Jessore and (24 May, 2015 and 26 June, 2015) at Ishurdi. In all locations, maize equivalent yield was computed by converting yield of intercrops on the basis of prevailing market price of individual crop following the formula of Bandyopadhyay (1984) as: Maize equivalent yield = Yim + (Yiisp × Pisp)/ Pm. Where, Yim = Yield of intercrop maize, Yiisp = Yield of intercrop Indian spinach, Pm = Market price of maize and Pisp = Market price of Indian spinach. Collected data of both the crops were analyzed statistically and the means were adjudged using LSD test. Economic analysis was also done considering local market price of harvested crops. Grain yield of maize was the maximum in sole crop but it was decreased 6.9-13.6 % at Joydebpur, 5.2-8.6 % at Jessore and 16.6-28.5 % at Ishurdi due to intercropping. All intercropping treatments showed better performance than maize sole crop. In intercropping, the highest maize equivalent yield (20.85 t ha^{-1} at Joydebpur, 12.83 t ha^{-1} at Jessore and 10.83 t ha^{-1} at Ishurdi), gross return (Tk. 312750 ha^{-1} at Joydebpur, Tk. 192450 ha^{-1} at Jessore and Tk. 162450 ha^{-1} at Ishurdi), gross margin (Tk. 202750 ha^{-1} at Joydebpur, Tk. 104080 ha^{-1} at Jessore and Tk. 82450 ha^{-1} at Ishurdi) and benefit cost ratio (2.84 at Joydebpur, 2.17 at Jessore and 2.03 at Ishurdi) were observed in hybrid maize paired row + 3 rows Indian spinach. The highest land equivalent ratio (1.35 at Joydebpur, 1.49 at Jessore and 1.25 at Ishurdi) was also found in the same treatment. The results revealed that hybrid maize paired row + 3 rows Indian spinach might be economically profitable for hybrid maize + Indian spinach intercropping system at Joydebpur, Jessore and Ishurdi regions.

Intermixed cropping of red amaranth with chilli under different seeding ratio

A field experiment was conducted at Joydebpur and RARS, Hathazari of Bangladesh Agricultural Research Institute during *rabi* season of 2015-2016 to find out suitable seed rate of red amaranth in chilli + red amaranth intermixed cropping system for higher productivity and monetary advantage. Six treatments were included in the experiment viz., T_1 = 100% chilli (50 cm × 40 cm) + 100% red amaranth (broadcast), T_2 = 100% chilli (50 cm × 40 cm) + 75% red amaranth (broadcast), T_3 = 100% chilli (50 cm × 40 cm) + 50% red amaranth (broadcast), T_4 = 100% chilli (50 cm × 40 cm) + 25% red amaranth (broadcast), T_5 = sole chilli (50 cm × 40 cm) and T_6 = sole red amaranth (broadcast). The experiment was laid out in RCBD with 3 replications. One month old seedlings of chilli (Manikgonj local variety at Joydebpur and Halda local variety at Hathazari) were transplanted on 17 November, 2015 at Joydebpur and 25 December, 2015 at Hathazari. After establishment of chilli seedlings, seeds of red amaranth (BARI Lalshak-1 variety in both locations) were sown according to treatments on 24 November, 2015 in Joydebpur and 01 January, 2015 at Hathazari. Sole red amaranth was fertilized with 40-10-30 kg ha^{-1} of NPK where, sole chilli and intercrop treatments were fertilized with 120-80-120-20-4 kg ha^{-1} of NPKSZn as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate in both locations. In sole red amaranth, ½ urea and all other fertilizers were applied as basal and remaining urea was top dressed at 20 DAE. In sole chilli & intercrop treatments, ½ urea and all other fertilizers were used as basal. Rest urea was applied (broadcast for intercrop) at 20 days after transplant (DAT), 50 and 70 DAT as ring method to chilli only. Irrigation and other intercultural operations were done as and when required in both locations. Red amaranth was harvested on 29 December, 2015 (35 DAS) at Joydebpur and 25 January, 2016 (31 DAS) at Hathazari. Chilli was harvested only 2 times by hand picking on 20 and 30 March, 2016 at Joydebpur. Most of the chilli plants were damaged due to heavy rainfall after second harvest. But in Hathazari ripen fruits of chilli were harvested on 25 April, 2016 and sun dried. Yield components of chilli were taken from randomly selected 5 plants from each plot. Yields of both the crops were taken from whole plot in both locations. Equivalent yields were computed using the formula of Bandyopadhaya (1984). Chilli equivalent yield = Yic + (Yir × Pr)/ Pc. Where, Yic = Yield of intercrop chilli, Yir = Yield of intercrop red amaranth, Pc = Market price of chilli and Pr = Market price of red amaranth. Data on yield and yield components of both the crops were analyzed statistically and the means were adjudged using LSD test. Economic analysis was also done considering local market price of harvested crops. The highest chilli equivalent yield (7.43 t ha^{-1} at Joydebpur and 3.31 t ha^{-1} at Hathazar), gross return (Tk. 222800 ha^{-1} at Joydebpur and Tk. 413750 ha^{-1} at Hathazari), gross margin (Tk. 124200 ha^{-1} at Joydebpur and Tk. 233750 ha^{-1} at Hathazari) and benefit cost ratio (2.26 at Joydebpur and 2.30 at Hathazari) were observed in100% chilli (50 cm × 40 cm) + 100% red amaranth (broadcast). The results revealed that 100% chilli (50 cm × 40 cm) + 100% red amaranth (broadcast) intermixed cropping might be agronomically feasible and economically profitable for chilli + red amaranth intermixed cropping system.

Yield performance of maize under different planting systems in T. aman- maize-mungbean cropping pattern

The experiment was conducted at Regional Agricultural Research Station, Jessore during rabi season of 2015-16 to evaluate the effect of planting systems on yield performance of maize under RCA systems. The soils are, in general, moderately deep and well drained with silty clay loam in texture having pH of 8.5. The experiment was designed with five planting systems, viz.T_1= Relay with T. aman, T_2= Dibbling after harvest of T. aman by manually, T_3= Dibbling after harvest of T. aman by puncture, T_4= Zero tillage maize planter and T_5= Conventional practice. The experiment was laid out in a Randomized Complete Block (RCB) design with three replications. For all the treatments, 30cm rice straw retained equally. The experimental site was ploughed as per treatment. The experimental plots were fertilized with N, P, K, S, Zn and Boron at the rate of 250, 55, 110, 40, 5, 1.5 kg/ha in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and Boric acid, respectively. In case of treatment $T_{1,}$ T_2 and $T_{3,}$ half of urea and the total amounts of other fertilizers were applied in the form granular before harvesting of T. aman rice. The rest of urea was top dressed on 40 and 60 Days after sowing (DAS). In case of treatment T_4 , half of urea and the total amounts of other fertilizers were applied in the form granular at the time of sowing. The seeds of BARI Hybrid maize-9 were treated with provex at the rate of 3g per one kg of seed. In case of treatment T_1 , the seeds were sown by hand at the rate of 2 seeds per hole with the spacing of line to line 60 cm and plant to plant 20 cm on 3 November 2015 and were later thinned to one plant per stand within 2 weeks after sowing (WAS). Tillage and fertilization method significantly influenced number of grains per cob and 1000 grain weight. The maximum number of grains per cob (585.1) was found in dibbling after harvest of T. aman by manually which was statistically similar to that of Zero tillage maize planter system (564.6). The lowest number of grain per cob (454.4) was found in relay with T. aman. The highest thousand grain weight (316.7 g) was obtained from relay with T. aman followed by conventional practice. The lowest thousand grain weight (280.0 g) was obtained from s dibbling after harvest of T. aman by manually followed by dibbling after harvest of T. aman by puncture. The highest grain yield (7.1 t/ha) was obtained conventional practice. The highest gross margin (Tk. 50,955/ha) was recorded from dibbling after harvest of T. aman by manually followed by dibbling after harvest of T. aman by puncture (Tk. 46,455/ha).

Intercropping of potato with maize under different planting system in southern region of Bangladesh

The experiment was carried out at Regional Agricultural Research Station, Rahmatpur, Barisal during the Rabi season of 2015-16. The experimental site belongs to the agro-ecological zone Ganges Tidal Floodplain (AEZ-13). The soil type is medium high land and soil texture is loamy. The treatments of the experiment were of two factors viz., Factor A: Planting time: 2 (T_1 = 15 November 2015. & T_2 = 30 November 2015); Factor B: Planting geometry: 4 (G_1 = 1-row maize (75 × 20 cm) + 1-row potato; G_2 = 1-row maize (60 × 20 cm) + 1-row potato; G_3 = Sole maize (60 × 25 cm) and G_4 = Sole potato (60 × 20 cm)). The experiment was laid out in split plot design with three replications. The unit plot size was 5 m × 4 m. The planting times were assigned in the main plots and the planting systems were imposed in the sub-plots. The variety of hybrid maize was BARI Hybrid maize-9 and potato variety was BARI Alu-7 (Diamant). The experiment was set up as per treatment specifications (sowing time). Fertilizers were applied in the experiment field at the rate of 570-290-300-230-18-6 kg/ha urea, TSP, MP, gypsum, zinc sulphate and boric acid, respectively along with 6 t/ha cowdung (FRG, 2012). Among the fertilizers, 1/3rd urea, half of other fertilizers and whole amount of cowdung were applied after final land preparation. One-third amount of urea was applied after sowing of maize and the rest amount other fertilizers (TSP, MP, gypsum, zinc sulphate and boric acid) were applied at the side of the potato row and covered with soil about 30-35 days after planting at the time of earthing up followed by irrigation. The rest 1/3rd of urea was applied as top dressing in maize plot after harvest of potato. Irrigation was applied for three times and other intercultural operations were done as when necessary following the recommended production technologies of the crops (BARI, 2014). In case of first sowing, the potato was harvested on 13 February 2016 and maize harvested on 05 April 2016. For second sowing, date of harvest of potato was 20 February 2016 and 20 April 2016 for maize the variety of hybrid Maize was BARI Hybrid Maize-9 and potato variety was BARI Alu-7 (Diamant). Results revealed that the effects of planting time, planting geometry and their interaction created significant variations in terms of tuber yield of potato. The tuber yield became the higher in 15 November planting date (9.11 t/ha) and the lower yield (5.75 t/ha) was found in 30 November planting. The highest yield of tuber was obtained from sole potato (11.48 t/ha) followed by G_1 (5.56 t/ha), which was statistically similar to that of G_2 (5.23 t/ha). The tuber yield was the highest (14.88 t/ha) in 15 November planting followed by 30 November sowing (8.08 t/ha) of sole potato. However, comparatively reduced yield was observed in T_1G_1 and T_1G_2 (6.53 and 5.90 t/ha). The lowest yield (4.55 t/ha) was found in T_2G_2 followed by T_2G_1 (4.62 t/ha). However, the planting time, planting geometry and their interaction had no significant effect on the grain yield of hybrid maize. Although the total net return maximum in 1-row maize (75×20 cm) +1-row potato with 15 November sowing date.

Intercropping of sweet gourd with brinjal at different plant population

The experiment was conducted at the Regional Agricultural Research Station, Jamalpur during rabi 2014-2015 and rabi 2015-2016 to find out the optimum population of sweet gourd mixed cropped with onion and to maximize the land utilization and benefit of the growers in the char areas. Design of the experiment was RCB with three replications having the unit of plot 4.8m × 3.6m. BARI Begun-10 and BARI Mistikumra-2 were used as a variety in the experiment. Treatments included in the experiment were: T_1= Sole brinjal (80cm × 60cm), T_2= Sole sweet gourd (2m × 2m), T_3= 100% Brinjal + 100% sweet gourd, T_4= 100% Brinjal + 75 % sweet gourd, T_5= 100% Brinjal + 50 % sweet gourd, T_6= 100% Brinjal + 25 % sweet gourd. Fertilizers were applied for sweet gourd at the rate of 40-18-50-12-0.7-0.6 g pit^{-1} N-P-K-S-Zn-B and for brinjal fertilizers were applied at the rate of 80-24-60-10-1.0-0.3 kg ha^{-1} of N-P-K-S-Zn-B in the form of Urea, triple super phosphate, Muriate of potash, Zypsum, Zinc Sulphate and Boric acid respectively. In case of sweet gourd all phosphorus, potassium, Sulphur, Zinc, boron and organic manure was applied in pit 5-7 days prior to planting while full amount of nitrogenous fertilizer was applied in to two equal installment around the plant by side dressing at 30 and 50 days after planting and mixed with soil followed by irrigation. In case of brinjal half cowdung was applied during the final land preparation. Remaining cowdung and full full phosphorus, sulphur, zinc and boron should be applied in pit before week of transplanting. Nitrogen and potassium was applied in three equal splits 21, 35 and 50 days after transplanting. Direct sweet gourd seed sown in the pit on 26 November, 2014 and 07 November, 2015 while 20 days after transplanting brinjal Seedlings. The result indicated that the highest gross return (Tk. 599300/ha) and cost of cultivation (Tk. 140000/ ha) were obtained from (2014-15 and 2015-16) 100% brinjal + 100% sweet gourd followed by 100% brinjal + 75 % sweet gourd. The highest gross margin (Tk 462200/ha) and BCR (4.37) were obtained from (2014-15 and 2015-16) 100% brinjal + 75 % sweet gourd followed by 100% brinjal + 100% sweet gourd. Brinjal equivalent yield (BEY) of all intercropping was higher than sole cropping indicating higher productivity of intercropping. The highest brinjal equivalent yield were (2014-15 and 2015-16) respectively, (29.97 and 28.65 t/ha) was found in 100% brinjal + 100% sweet gourd followed by 100% brinjal + 75 % sweet gourd.

Suitability study of different winter vegetables with sweet gourd

The experiment was conducted at Joydebpur, RARS, Hathazari and ARS, Rajbari of Bangladesh Agricultural Research Institute during two successive rabi seasons (2014-2015 and 2015-2016) to find out the suitable vegetable for intercropping with sweet gourd for higher productivity and economic return. Six intercrop combinations of sweet gourd and vegetables viz., $T_{1=}$ sole sweet gourd T_2=100% sweet gourd (2m × 2m) + 62.5% cabbage (80 cm × 50 cm), T_3 =100% sweet gourd (2m × 2m) + 62.5% cauliflower (80 cm ×50 cm), T_4 =100% sweet gourd (2m × 2m) + 56.8% radish (80 cm x 10 cm), T_5 =100% sweet gourd (2m × 2m) + 62.5% lettuce (80 cm × 50 cm), T_6 =100% sweet gourd (2m × 2m) + 62.5% tomato (80 cm × 50 cm) were tested at Joydebpur and Rajbari. At Hathazari lalshak and broccoli was used instead of lettuce and radish. The experiment was laid out in a RCB design with 3 replications. BARI Misti kumra-2, BARI Badhacopy-1, BARI Fulcopy-1, BARI Tomato-2, BARI lettuce-1 BARI Mula-1 , BARI Lalshak -1 and BARI Broccoli-1 were used in this experiment. Fertilizers @ 80-36-100-24-2-2 kg/ha NPKSZnB+ CD: 10 t/ha were applied in sole sweet gourd and in intercrop treatments fertilizers @ 100-50.5-90.5-18-2.3 kg/ha NPKSZnB+ CD: 10 t/ha were applied. All of organic manure and chemical fertilizers were applied at the final land preparation, while urea and MoP were top dressed in two equal splits at 15 and 35 DAT of winter vegetables. The highest mean sweet gourd yield (31.37t/ha at Joydebpur, 34.54t/ha at Rajbari and 24.23 t/ha at Hathazari) was recorded in sole sweet gourd and the lowest (18.02 t/ha at Joydebpur, 7.83 t/ha at Rajbari and 15.89 t/ha at Hathazari) was found in T_6 (100% sweet gourd + 62.5% tomato (80 cm × 50 cm) in both the years. The highest mean vegetable yield (42.87 t/ha at Joydebpur and 61.40 t/ha at Rajbari) was recorded in 100% sweet gourd + 62.5% cabbage combination. On the other hand, the highest vegetable yield (18.05 t/ha) was recorded in 100% sweet gourd + 62.5% tomato combination in both the years at Hathazari. Maximum mean sweet gourd equivalent yield (72.55 t/ha), the highest gross return (Tk.362775/ha and BCR (2.98) were recorded in 100% sweet gourd + 62.5% Cabbage combination in both the years at Joydebpur. The maximum mean SEY (79.38 t/ha), the highest gross return (Tk.396905/ha) and BCR (3.25) were recorded in 100% sweet gourd + 62.5% cauliflower combination at Rajbari and the lowest in sole sweet gourd. Whereas, at Hathazari, the maximum mean SEY (37.49 t/ha), gross return (Tk. 187455/ha) and BCR (2.35) were obtained from 100% sweet gourd + 62.5% tomato combination in both the years. Two years result revealed that 100% sweet gourd + 62.5% cabbage, cauliflower and tomato might be suitable intercrop combination for getting maximum yield and economic return.

Development of five crop-based cropping pattern for increasing cropping intensity and productivity

The experiment were conducted at the research field of Agronomy Division BARI, Joydebpur, Gazipur, RARS, Jessore (AEZ 11), RARS, Burirhat farm, Rangpur, RARS, Jamalpur (AEZ-8) and RARS, Ishurdi, Pabna during the rabi season of 2013-14 and 2014-15 to increase cropping intensity and productivity in rice based cropping system for sustaining food security, poverty reduction, resource management and livelihood improvement of ever increasing populations. Six treatments of cropping sequence were as follows: CP_1 = Potato- Mungbean- T. aus- T. aman CP_2 = Potato- Lalshak- Mungbean- T. aus- T. aman, CP_3 = Mustard- Lalshak- Mungbean- T. aus- T. aman, CP_4 = Gardenpea- Boro- T. Aus- T. aman, CP_5 = Gardenpea- Lalshak- Mungbean- T. aus- T. aman and T. aman CP_6 = Fallow- Boro- Fallow- T. aman (Farmers practice). The experiment was laid out in a RCB design with 4 replications. The unit plot size was 5 m x 4m. Recommended doses of fertilizers were used for all crops. Potato (cv. Diamant) was planted with 60 cm x 25 cm spacing on 10 to 22 November, 2014 and harvested on 5 to 14 February, 2015 at different locations. Mustard variety BARI Sarisha-14 was sown with 30 cm x 5 cm spacing on 27 October to 18 November, 2014 and harvested on 18 January to 10 February, 2015. BARI Motorshuti-3 was sown with 30 cm x 5 cm spacing on 9 November to 23 November, 2014 and harvested on 9 January to 03 February 2015. BARI Lalshak-1 was broadcast on 14 January to 07 February, 2015 and harvested on 17 February to 08 March, 2015. Mungbean seeds (BARI Mung-6) were sown on 22 February to 12 March, 2015 and harvested on 5 to 20 May, 2015. Boro rice 40-45 days old seedlings of BRRI dhan 28 were transplanted with 20cm x 15cm spacing on 20 January to 05 February, 2015 in CP_4 and CP_6 and harvested on 02 to11 May, 2015. T. Aus (Parija) was transplanted with 15cm x 10 cm spacing on 02 to 23 May, 2015 during Kharif season and harvested on 16 July to 08 August, 2015. T. aman (Bina dhan 7) were transplanted with 20cm x

15cm spacing on 19 July to 08 August, 2015 and harvested on 20 October to 03 November, 2015 at different locations. The results indicated that cropping sequence CP_2: Potato- Lalshak Mungbean- T. aus- T. aman followed by CP_5: Gardenpea- Lalshak- Mungbean- T. Aus- T. aman might be suitable for getting higher rice equivalent yield (REY) (CP_2: 31.74 t/ha and CP_5: 27.21 t/ha). The lowest REY (9.36 t/ha) was obtained from the cropping sequence T. aman – Fallow – Boro – Fallow. Inclusion of Lalshak during *rabi* season and mungbean during kharif-I season in CP_2 and CP_5 increased REY 239 to 191% compared to farmer's pattern CP_4. From one year study it was observed that highest total productivity (31.74 t/ha), gross return (Tk. 476000/ha) and gross margin (Tk. 215049 ha) were obtained from CP2: Potato- Lalshak- Mungbean- T. aus- T. aman cropping pattern. Gardenpea-Lalshak- Mungbean- T. aus- T. aman cropping pattern gave the highest profitability interns of MBCR (2.11) due to lower variable cost.

Intercropping squash with maize under varying planting system

The experiment was conducted at Joydebpur, Gazipur, RARS, Hathazari and ARS, Rajbari of BARI during rabi season of 2014-15 and 2015-16 to find out the suitable planting arrangement of squash intercropped with maize. Seven treatments combinations viz., T_1=maize normal plating (75cm × 25cm), T_2=maize normal plating (100%) + 1 row squash (Pl. to Pl. 80cm) (116%), T_3=Maize paired row (100%) + 1 row squash (Pl. to Pl. 80cm) (50%), T_4=maize paired row (100%) + 1 row squash (Pl. to Pl. 100cm) (40%), T_5=maize paired row (100%) + 2 row squash (Pl. to Pl. 80cm) (100%), T_6=maize paired row (100%) + 2 row squash (Pl. to Pl.100cm) (80%), T_7=Sole squash (100cm × 80cm) were tested. The experiment was laid out in RCB design with 3 replications. BARI Hybrid Maize-9 and squash were used as test crop in this experiment. Seeds of both crops were sown on 24 November 2014 and 20 November 2015 in Joydebpur, 21 November 2014 and 11 November 2015 in Rajbari and last week of December in Hathazari. Fertilizers @ 250-120-120-40-5 kg/ha NPKSZn + CD:10 t/ha were applied in sole maize and in intercrop treatments. Half N and all other fertilizer was applied as basal. Rest N was applied at 15 and 35 DAS in two equal splits. Additional 40 kg/ha N were applied in intercropping plot. In sole squash the crop was fertilized at the rate of 80-35-75-20-4-2 kg/ha NPKSZnB + CD:20 t/ha + additional 40 kg/ha N were applied. Chemical fertilizers were used in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid. Intercultural operations like watering, weeding and pest control were done as and when required. Squash was harvested during 21 January to 24 February in 2015 and 20 January to 16 February in 2016 in Joydebpur. In Rajbari Squash was harvested on January 26- February 26, 2015 and January 5-February 15, 2016. In Hathazari squash was harvested on last week of February to last week of March and maize was harvested on 22 and 25April, 2015 and 2016 respectively in Joydebpur. In Rajbari maize was harvested on April 23, 2015 and April 18, 2016. In Hathazari maize was harvested on last week of April. Yield components of both crops were taken from randomly selected 5 plants from each plot. Yields of both the crops were taken from whole plot. Maize equivalent yield was computed using the formula of Bandyopadhaya (1984). Collected data of all crops were analyzed statistically and the means were adjudged using LSD test. Maximum maize equivalent yield was recorded in maize paired row (100%) + 2 row squash (Pl. to Pl. 80cm) (100%) combination at Joydebpur, maize normal row 100% + 1 row squash (Pl. to Pl. 80cm) (116%) at Rajbari and maize paired row (100%) + 1 row squash (Pl. to Pl. 100cm) (40%) at Hathazari. The highest gross return (Tk. 293850 ha^{-1}), gross margin (Tk. 192450 ha^{-1}) and BCR (2.95) were obtained from maize paired row (100%) + 2 row squash (Pl. to Pl. 80cm) (100%) at Joydebpur. In Rajbari, the maximum gross return (Tk.392875 ha^{-1}) gross margin (Tk. 316875 ha^{-1}) and BCR (5.16) were found in maize normal plating (100%) + 1 row squash (Pl. to Pl. 80cm) (116%). On the other hand the highest gross return (Tk. 124030 ha^{-1}), gross margin (Tk. 74000 ha^{-1}) and BCR (2.47) was recorded in maize paired row (100%) + 1 row squash (Pl. to Pl. 100cm) (40%) at Hathazari. The two years results revealed that maize paired row (100%) + 2 row squash (Pl. to Pl. 80cm) (100%) combination for Joydebpur, maize normal plating (100%) + 1 row squash (Pl. to Pl. 80cm) (116%) for Rajbari, and maize paired row (100%) + 1 row squash (Pl. to Pl. 100cm) (40%) for Hathazari was found suitable for higher productivity and economic return.

Intercropping french bean with brinjal at varying planting system

The experiment was carried out at the research field of Agricultural Research Station, Rajbari, Dinajpur during rabi season of 2014-15 and 2015-16 to find out suitable crop combination for higher productivity and economic return. Six different treatments were employed in this study viz. T_1=Sole brinjal (75 cm × 60 cm), T_2=Sole french bean (30 cm × 10 cm), T_3 =Brinjal normal row (100%) + 1 line french bean in between brinjal (33%), T_4 = Brinjal normal row (100%) + 2 lines french bean in between brinjal (66%), T_5 = Brinjal paired row (100%) + 3 lines french bean in between brinjal (40%) and T_6 = Brinjal paired row (100%) + 4 lines french bean in between brinjal (53%) were evaluated. The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Fertilizers were applied @ 160-48-120-20-3-0.9 kg ha^{-1} N-P-K-S-Zn-B for both the sole brinjal and intercrop combinations. Except N and K, full amount of all other fertilizers were applied in pit before 1 week of transplantation. N and K was applied in 3 equal splits at 21, 35 and 50 days after transplanting (DAT) in brinjal as ring method followed by irrigation. Under intercropping situation no additional fertilizer was applied for bush bean and bush bean was grown in those treatments with the fertilizer applied for brinjal. In the case of sole bush bean, fertilizers were applied @ 120-40-60-12-3 kg N-P-K-S-Zn ha^{-1}, respectively (FRG, 2012). Half of N and full amount of other fertilizers were applied at final land preparation and the rest N was top dressed at 35 days after sowing (DAS). Thirty days old seedlings of brinjal was transplanted on 20 November 2014 and 08 November 2015 and bush bean was sowing 10 days after transplanting of brinjal in line according to the treatment combinations. Seeds of BARI Begun-10 and BARI Bt Begun-1 were used in 2014-15 and 2015-16, respectively. In both the years, seeds of BARI Jharsheem-2 were used. Intercultural operations like watering, weeding and pest control were done as and when required. First harvesting of brinjal was done at 119 DAT and the harvesting was continued up to 208 DAT. French bean was harvested three times at 87, 98 and 115 DAS. Yield components of brinjal and bush bean were taken from randomly selected 10 plants from each plot. Yields of both the crops were taken from whole plot. Brinjal equivalent yields (BEY) were computed using the formula of Bandyopadhaya (1984). Treatments were compared in terms of land equivalent ratio and % land save using the formula developed by Willey (1985). Collected data of all crops were analyzed statistically by using MSTAT software packages and mean differences for each character were compared by Least Significant Difference (LSD) test (Gomez and Gomez. 1984). The highest yield of brinjal (20.15 t ha^{-1} in 2014-15 and 21.78 t ha^{-1} in 2015-16) and french bean (47.56 t ha^{-1} in 2014-15 and40.97 t ha^{-1} in 2015-16) was obtained from sole cropping. Under intercropping, the highest brinjal yield (17.47 t ha^{-1} in 2014-15 and 14.65 t ha^{-1} in 2015-16) was recorded in brinjal normal row + 1 line french bean in between brinjal, while, the highest french bean yield (43.12 t ha^{-1} in 2014-15 and 34.10 t ha^{-1} in 2015-16) was recorded in brinjal normal row + 2 lines french bean in between brinjal. The highest brinjal equivalent yield (58.47 t ha^{-1}), land equivalent ratio (1.59) gross return (Tk 450800 ha^{-1}), gross margin (Tk 348450 ha^{-1}) and BCR (4.40) were also obtained from brinjal normal row + 2 lines french bean in between brinjal. The two years results indicated that brinjal normal row + 2 lines french bean in between brinjal was found suitable for higher productivity and economic return.

Itercropping coriander with brinjal for fruit and shoot borer insect suppression

A field experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur during rabi season of 2014-15 and 2015-16 to find out suitable intercrop combination of coriander with brinjal for insect suppression, maximize the land utilization for higher yield and economic benefit. There were six treatments in the experiment viz. T_1=Sole brinjal (100cm × 75cm), T_2=Sole coriander (broadcast), T_3=100% brinjal+ 25% coriander (One row coriander between two row brinjal), T_4=100% brinjal+ 50% coriander (Two row coriander between two row brinjal), T_5=100% brinjal+ 75% coriander (Three row coriander between two row brinjal), T_6=100% brinjal+ 100% coriander (Broadcast). The maximum infestation of brinjal fruit and shoot borer was observed in sole brinjal (Fruit infestation in 2014-15 was 77.59% and in 2015-16 was 71.29%), (Shoot infestation in 2014-15 was 78.23% and in 2015-16 was 77.35%). The infestation was reduced with the increase of coriander population intercrop situation. The minimum infestation of was in treatment T_6 (Fruit infestation was 39.33% and was 38.77% in 2014-15 and 2015-16), (Shoot infestation in 2014-15 was 29.98% and in 2015-16 was 45.92%). Brinjal yield and yield components were inversely related to brinjal fruit and shoot borer infestation. The highest brinjal yield 15.33 t ha^{-1} (2014-15) and 14.63 t ha^{-1}(2015-16) was obtained from treatment T_3 while the lowest 3.00 t ha^{-1} (both in 2014-15 and 2015-16) from T_1 treatment. The highest brinjal equivalent yield (16.47 t ha^{-1} and 15.94 t ha^{-1}), gross return (Tk. 2, 47,050 ha^{-1} and 2,39,100 ha^{-1}), gross margin (Tk. 1,35,050 ha^{-1} and 1,27,100 ha^{-1}) and benefit cost ratio BCR (2.21 and 2.13) in 2014-15 and 2015-16, respectively were obtained from treatment T_4 while the lowest from T_1 treatment.

Intercropping coriander with chickpea for pod borer insect suppression

A field experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur during rabi season of 2014-15 and 2015-16 to find out suitable intercrop combination of coriander with chickpea for pod borer insect suppression and economic benefit. There were six treatments in the experiment viz. T_1=Sole Chickpea (40cm line spacing), T_2=Sole coriander (broadcast), T_3=100% Chickpea + 25% coriander (One row coriander between two row chickpea), T_4=100% Chickpea + 50% coriander (Two row coriander between two row chickpea), T_5=100% Chickpea + 75% coriander (Three row coriander between two row chickpea), T_6=100% chickpea + 100% coriander (Broadcast). The maximum pod borer infestation was observed in sole chickpea 13.71% and 13.40% respectively during 2014-15 and 2015-16. Infestation was reduced with the increase of coriander population intercrop situation. The minimum (3.65% in 2014-15 and 3.99% in 2014-16) pod borer infestation was recorded in T_4 treatment. Chickpea yield and yield components were inversely related to pod borer infestation. During 2014-15 and 2015-16 the highest chickpea yield (1.40 t ha^{-1} and 1.42 t ha^{-1}) was obtained from treatment T_4 while the lowest (1.03 t ha^{-1} and 1.12 t ha^{-1}) from T_1 treatment. The highest chickpea equivalent yield (1.79 t ha^{-1} and 1.82 t ha^{-1}), gross return (Tk. 1, 25,020 ha^{-1} and Tk. 1,27,400 ha^{-1}), gross margin (Tk. 36,000 ha^{-1} and Tk. 38,400 ha^{-1}) and benefit cost ratio BCR (1.41 and 1.43) were obtained from treatment T_4 while the lowest from T_1 treatment both the years 2014-15 and 2015-16, respectively.

Unfavourable Eco-System

Intercropping of mungbean with chilli at different planting system for coastal area

The experiment was conducted at the MLT site, Batiaghata, Khulna during late rabi season of 2015-16 to find out the appropriate intercrop combination of mungbean with chilli for higher productivity and maximum economic return. The experiment was considered with five crop combinations viz. T_1: sole chilli (BARI Morich-2), T_2: sole mungbean (BARI Mung-6), T_3: One row chilli with one row mungbean (6 lines chilli+5 lines mungbean), T_4= Two row chilli with one row mungbean (6 lines chilli+2 lines mungbean), T_5= Two row chilli with two row mungbean (6 lines chilli+ 4 lines mungbean). The land was fertilized with 10 ton decomposed cowdung and inorganic fertilizer @ 100-63-100-18 kg ha^{-1} NPKS, respectively (FRG, 2012). The whole amounts of cowdung, P, S and 1/4th of K were applied at the time of final land preparation. Remaining K and whole amounts of N were applied in three equal installments at 25, 50 and 75 days after transplantation from 10-12 cm away from the base of the plant which is also beneficial for the growth and yield of mungbean. Thirty days old chilli seedlings transplantation and mungbean sowing were done 17 February 2016. Among the intercropping treatments, the highest chilli equivalent yield (9.74 t ha^{-1}) and highest land equivalent ratio (1.77), gross return (Tk. 194,766.50 ha^{-1}), gross margin (Tk. 97767 ha^{-1}) and BCR (2.01) was obtained from T_3 treatment. From the experiment it was found that intercropping of one row chilli with one row mungbean might be suitable combination for higher productivity and economic return.

Survey on crops and cropping at chalan beel areas of Bangladesh

A field survey was conducted in chalan beel area to find out the existing crops and cropping system to take necessary steps for increase agricultural productivity and cropping intensity. Three upazilla named Gurudashpur, Tarash and Chatmohor of Natore, Shirajgonj and Pabna districts, respectively were considered as survey area. Fifty farmers of each location with a total of 150 were randomly selected to collect information through questionnaire. Most of the farmers are marginal land owener (0.21-0.6 ha). Most of them are illiterate and primary school level educated. They cultivate garlic, jute, rice, maize, lentil, mustard, wheat and water melon. Most of the rabi crops are oriented to local varieties. Farmers of Chalan beel dominantly cultivate garlic-jute-T.aman and mustard-boro-fallow cropping sequence depending on land topography. Among the farmers, 20% of Gurudashpur and 30% of Chatmohor cultivate dominating pattern of garlic-jute-T.aman. At Tarash 41% of the respondent cultivate mustard-boro cropping sequence. Farmers use different fertilizers but the application dose and method varied markedly in location to location. Therefore, adaptive trial with modern and high yielding varieties of different crops and under different fertilizes level should be under taken to increase the productivity and cropping intensity of the Chalan beel.

Performance of vegetables under floating agriculture based different production systems

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal from September 2015 to January 2016 to develop alternate production system for submerged/flooded ecosystem. Performances of two vegetable crops *viz*., pumpkin (var. Local) and bottle gourd (var. BARI Lau-2) were evaluated under three production systems *viz.*, i) Plastic drum based floating trellis, ii) Dyke method, and iii) Trellis on normal land. The experiment was laid out in randomized complete block design with two replications. The unit floating bed size was 5 m × 3 m. Seedlings of pumpkin and bottle gourd were transplanted on 12 September 2015. Experimental results revealed that the studied parameters (number of fruit/plant, fruit/plot, single fruit weight and fruit yield/plot) of pumpkin and bottle gourd were not statistically significant due to different production systems. The highest fruit yield (32.07 t/ha) of pumpkin was achieved from the trellis on normal land followed by drum based floating trellis (31.52 t/ha). Similarly, bottle gourd also showed the highest fruit yield (26.70 t/ha) in trellis on normal land. However, fruit yields of bottle gourd obtained from dyke method and drum based floating trellis were 24.53 and 23.30 t/ha, respectively. It can be concluded that drum based floating trellis might be alternative production system for creeping vegetables cultivation but the technology should be improved further to make it cost effective.

Performance of different vegetable and spice seedlings on floating bed

The experiment was conducted at Mugarjhor village, Nazirpur, Pirojpur from October to November, 2015 to evaluate the seedlings performance of vegetable and spices crops on water hyacinth made floating bed. Seedlings performance of three vegetables and one spice crops viz., bottle gourd, papaya, brinjal and chilli were evaluated on water hyacinth made floating bed. The experiment was laid out in randomized complete block design with three dispersed replications. The unit floating bed size was 5 meter long and 1.5 meter wide. At first, the seeds of bottle gourd (BARI Lau-4), papaya (Local), brinjal (BARI Begun-7) and chilli (BARI Morich-1) were sown on dissected coconut fiber made nursery bed at farmers' homestead areas. After emergence, the seedlings were placed in small balls (prepared with decomposed water hyacinth/topapana) and then they were kept under nursery shade condition for a week for intensive care as well as hardening of the seedlings. Thereafter, the seedling balls were shifted to the main floating bed made by water hyacinth. No fertilizer and manure were applied during seedling production. The seedlings were harvested during 26-30 November 2015 (25-30 days after sowing), when they attained the optimum age for transplanting in the main field. Research findings revealed that the number of seedlings of bottle gourd, papaya, brinjal and chilli were 26.00, 52.00, 32.67 and 38.67/m^2, respectively. At 20 days after sowing, seedling height of bottle gourd, papaya, brinjal and chilli were observed 12.47, 11.30, 12.78 and 10.56 cm, respectively. The number of seedling production per unit plot of bottle gourd, papaya, brinjal and chilli were 195, 390, 245 and 290, respectively. From the results, it can be concluded that seedling production of different vegetables and spices through floating bed has the potentiality in the submerged/flooded ecosystems where normal land is very scarce.

Performance of different potato varieties grown with decomposed water hyacinth on sorjan bed

The field experiment was implemented at Mugarjhor village, Nazirpur, Pirojpur during Rabi season of 2015-16. BARI developed three varieties of potato viz., BARI Alu-7 (Diamant), BARI Alu-8 (Cardinal) and BARI Alu-13 (Granola) were used as treatment variables in this experiment. The experiment was laid out in randomized complete block design (RCBD) with three dispersed replications. The unit plot size was 5m × 1.5m. After monsoon season, the decomposed materials (water hyacinth, topapana, dulalilata etc.) floating bed were put on the nearby sorjan beds with 25-30 cm thickness. The whole sorjan bed was then splitted into three plots, where three potato varieties were grown. Seed tubers were planted on 8 December 2015 with spacing of row to row distance 60 cm and plant to plant 25cm. Seeds were placed into 5-6 cm depth. Initially, fertilizer was not applied but nitrogen (N) and potassium (K) at the rate of 130 and 120 g/plot were applied as side dressing after 30 days of planting followed by irrigation. Potato crop was harvested on 8 February 2016. Results showed that plant population/plot, tuber weight/plot and tuber yield of potato differed significantly among the varieties. Potato variety Diamant exhibited the highest weight of tuber (52.91 kg/plot), which was similar to that of Cardinal (48.28 kg/plot), while the lowest weight was achieved from Granola (41.88 kg/plot). Similarly, Diamant gave the highest yield of tuber (26.46 t/ha), which was identical to that of Cardinal (24.14 t/ha) but Granola had the lowest yield (20.94 t/ha). Although the Diamant and Cardinal varieties grown with decomposed water hyacinth on sorjan bed gave satisfactory yield but the experiment should be continued in the next year for making final recommendation.

Influence of sowing time based temperature on flowering and seed yield of french bean (*Phaseolus vulgaris* L.)

A field experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur during rabi season of 2015-16 to evaluate the flowering behavior and seed yield of French bean. The twelve treatment combinations were studied in this experiment. The main plots were consisted of four sowing dates viz., 15 November, 30 November and 30 December. The sub-plots were arranged with three varieties of Jharsheem (BARI Jharsheem-1, BARI Jharsheem-2 and BARI Jharsheem-3).The experiment was laid out in a split plot design with three replications. The crop was fertilized with 120-40-60-12-3 kg N-P_2O_5-K_2O-S-Zn /ha, respectively (FRG, 2012). Half of N and full doses of other fertilizers were applied at the time of final land preparation and the rest urea was top dressed at 35 days after sowing (DAS). Sowing date based temperature variations significantly affected the flowering behaviour and seed yield of French bean varieties. Crop developmental events and growth duration were influenced by prevailing temperature. Crop growth duration was recorded maximum in BARI Jharsheem -2 sown on 15 November (107 days) followed by 30 November (104 days). The minimum duration (76 days) was recorded in BARI Jharsheem-3 sown at 30 December. The reasons for variation in growth duration might be due to increased day and night temperature at late sowing. Flowering duration of 15 November and 30 November sowings were longer due to prevailing low temperatures (Min.11.72-13.24^{0}C and Max 25.02-25.82^{0}C). On the contrary, minimum flowering duration was recorded in 30 December sown crop (11-17 days). Minimum duration might be due to prevailing high temperature (Min. 16.05-18.61^{0}C and Max 28.89-31.31^{0}C) that shorten the flowering duration of all French bean varieties. November sowing performed better in relation to yield components and yield than other sowing. BARI Jharsheem-1 produced the highest seed yield (1734kg ha^{-1}) in 15 November which was statistically similar to 30 November sowing. The lowest seed yield (421kg ha^{-1}) was obtained from 30 December sowing from BARI Jharsheem-2. French bean sown on November to December showed the greater variability with respect to flowering, duration of flowering and the number of pods. Results revealed that November would be the optimum time of sowing for getting maximum flowering duration and seed yield of BARI Jharsheem-1.

Effect of delayed sowing and management practices on phenology, growth and yield of garden pea

The experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and RARS, Burirhat, Rangpur during rabi season of 2015-2016 to find out the relation between different development events of garden pea crop and the sowing time based temperature and also to minimize the yield reduction by management practices. The treatments were comprised with three sowing dates viz., i. 30 November (D_1), ii. 15 December (D_2) and iii. 30 December (D_3), and three management practices viz., i. Low: 25-30-56-5 kg NPKS/ha, no irrigation, no weeding, no pesticide (M_1). ii. Medium: 25-30-56-5 kg NPKS/ha, one weeding at 21 DAE, two irrigations at pre flowering and pod development stages, one weeding at 21 DAE and spraying pesticides (M_2). iii. High: 30-36-67-6 NPKS kg/ha (additional 20% of the recommended dose) + two irrigation at pre flowering and pod development stage, Seed treatment, one weeding at 21 DAE (M_3). The experiment was laid out in a split-plot design with three replications. The sowing dates were assigned in the main plots and management practices were arranged in sub-plots. BARI motorshuti-3 was used as test crop. Seeds were sown in lines with maintaining 30 cm row to row spacing. All the phonological events varied on sowing dates and management practices. The 30 November sowing took maximum days for first flowering (32 days) and 50% flowering (35 days) whereas 30 December sowing took minimum days for first flowering (26 days) and 50% flowering (29 days). The days for harvesting maturity (fresh pod) were varied by sowing date and management practices. The 30 November sowing took maximum days (64) and 30 December sowing took minimum days (51) for harvesting maturity. Low management practices took minimum days for harvesting fresh pod. The minimum days for harvesting maturity were found in 30 December sowing (51 days) at low management practices. The maximum days needed for pod harvest (64 days) was recorded both in medium and high management practices done at 30 November sowing. Under high management, December 30 sowing took minimum days (55days) to reach the harvesting maturity. The results indicated that the number of days required for attaining different phenological stages decreased with delay sowing at Joydebpur. Significantly the highest total dry matter (46.5gm^{-2}) was recorded in 30 November sowing with high management practices. The lowest total dry matter (14.68 g m^{-2}) was recorded at 30 December sowing with low management practices which was identical with medium management practices at the same date of sowing. Significantly the highest pod yield was recorded from 30 November sowing with high management practices (14.77 t /ha at Joydebpur and 9.63 t /ha at Burirhat) and the lowest pod yield (8.98t ha^{-1}) was obtained from 30 December sowing with low management practices at Joydebpur. Yield reduction in late sowing was reduced to some extent by high management practices.

Effect of fertilizer package on yield and yield contributing characters of onion in hilly area

An experiment was conducted at Khagrachari, Hill Agricultural Research Station, Bangladesh Agricultural Research Institute during *rabi* 2015-16 to find out suitable fertilizer packages of onion in hilly area. Four fertilizer packages viz. T_1: 60-12-40-10-5000 kg ha^{-1} of N-P-K-S-CD, T_2: 120-24-80-20-5000 kg ha^{-1} of N-P-K-S-CD (FRG, 2012), T_3: 240-48-160-40-5000 kg ha^{-1} of N-P-K-S-CD and T_4: 0-0-0-0-0 kg ha^{-1} of N-P-K-S-CD were used in this experiment. The experiment was conducted in randomized complete block design with three replications. Onion variety BARI Peyaj -5 was used as test crop. All the amount of CD, TSP, gypsum, half of urea and MoP were applied as basal during final land preparation and mixed adequately with the soil. The rest urea and MoP were applied in two splits, one at 25 days after transplanting (DAT) and the other at 50 DAT. Thirty five days old seedlings were transplanted in the main field on 14 December, 2015 by maintaining 20 cm × 10 cm spacing. Intensive care was taken during the growing period to ensure adequate growth and development of the crop. The data on plant height, plant population/linear meter, length of bulb, individual bulb weight and yield were recorded. The data were analyzed statistically by using MSTAT software. The fertilizer package of 120-24-80-20-5000 kg ha^{-1} of N-P-K-S-CD was recorded better in case of plant height, plant population/linear meter, length of bulb, diameter of bulb, individual weight (g) and yield (t/ha) than other packages. The results revealed that FRG, 2012 recommended nutrient (120-24-80-20-5000 kg ha^{-1} of N-P-K-S-CD) gave the maximum yield of onion in hilly soil and might be economically profitable at the hilly areas.

Fertilizer management of lentil at char land area of Bhuapur, Tangail

The experiment was conducted at the Charland of the Jamuna river under the MLT site, Bhuapur, Tangail during the *rabi* 2015-16 to find out economic fertilizer dose for lentil and to increase production and economic return**.** The soil of the experimental field was silty loam in texture with pH 6.97 belonging to Grey Floodplain soil (AEZ# 8). The experiment was laid out in RCB design with three replications. Five fertilizer packages viz., T_1: 24-32-30-18-0.4 kg ha^{-1} N-P-K-S-B (Based on HYG, FRG, 2012), T_2: 21-17-20-0-0 kg ha^{-1} N-P-K-S-B (based on PRC, BARI), T_3: 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (Based on STB), T_4: Farmers practice (17-8-19-14-0) and T_5: 0-0-0-0-0 (Native fertilizer/control) were considered as treatments. All the fertilizers were applied at the time of final land preparation in the form of urea, triple super phosphate, muriate of potash, gypsum and boric acid, respectively. The crop variety was BARI Mosur-6. The seeds were sown on 23 to 25 November, 2015 maintaining 30 cm x 5 cm spacing with seed rate of 35 kg ha^{-1}. Two weeding were done at 31 and 53 DAS. Other necessary managements were done as and when necessary. The crop was harvested on 11 to 13 March, 2016. The maximum grain yield of lentil (1.56 t ha^{-1}), gross return (Tk. 108967 ha^{-1}) and gross margin (Tk. 74045 ha^{-1}) and benefit cost ratio (3.12) were recorded from fertilizer package of 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (Based on soil test). The results indicated that fertilizer package of 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (Based on soil test) might be suitable for getting maximum seed yield of lentil and benefit cost ratio in the charland area of Bhuapur, Tangail.

Effect of K- nutrition on water stress tolerance of soybean

A field experiment was carried out at the research field of Agronomy Division, BARI, Gazipur during late-rabi season of 2015 and 2016 to find out the optimum dose of K which enables soybean plant to adapt to drought stress. Seven doses of K viz., control (0% K, native dose), 100% STB potassium, 125% STB potassium, 150% STB potassium, 175% STB potassium 200% STB potassium and 225% STB potassium were evaluated under two levels of water regimes; Wc = no water stress (control) and Ws= water stress (Rainfed). The treatment 225% STB potassium was not included in 2015. The experiment was laid out in a randomized complete block design (Factorial) with three replications. Drought had been imposed by withdrawing of irrigation water till wilting symptom appeared and then irrigated. About 86 and 206 mm rainfall occurred during drought imposing periods in 2015 and 2016, respectively. Two pretreatment irrigations were given initially prior to imposing the treatments for crop established. The unit plot size was 3m x 3m. The spacing was maintained 30cm x 10cm. Seeds were sown on 19 January in both the year. Fertilizers (except K) were applied at the rate of 24-30-15 kg/ha of NPS as urea, triple super phosphate (TSP) and gypsum. All fertilizers were applied at final land preparation. Weeding and other intercultural operations were done as and when necessary. Growth parameters were measured at different growth stages. Five plants per plot were sampled at different growth stages for recording growth parameters. Leaf area was measured with an automatic leaf area meter (L13100C, LI-COR, USA). The plant materials were dried in an oven at 70^{0}C for 72 hours and dry weight was recorded. Crop was harvested on 15 may in 2015 and 2 May in 2016. The yield components data were collected from 5 randomly selected plants prior to harvest from each plot. At harvest, yield data were recorded plot wise and analyzed statistically. Soil moisture were collected at 15 days interval at a depth of 0-15 and 15-30 cm. Variation in potassium dose greatly influenced the growth and yield of soybean under both the water regimes. Drought stress showed significant influence on growth, yield contributing characters and seed yield. The maximum plant height, leaf area index and total dry matter were obtained with higher dose of K (200% STB of potassium) in 2015, but in 2016 it was in 225% STB potassium treatment which was statistically similar with 200% STB potassium treatment. Yield contributing characters also showed the same trend which reflected on the seed yield of treatment 225% STB potassium. The lowest yield was obtained in water stress plot with native dose of K. The results of the experiment showed that under water deficit condition K-dose of 225% STB had greater influence on the growth and yield of soybean.

10 IRRIGATION AND WATER MANAGEMENT

Background

Irrigation and Water Management Division is one of the research divisions of BARI. It conducts research on irrigation scheduling, on-farm water management and generation of basic information of BARI mandated crops. It also generate information through research on water quality, agricultural drainage, pumps and tube wells for both ground and surface waters. Irrigation and Water Management Division is also engaged with saline soil and water management research, micro irrigation systems and development of hill irrigation.

Effect of deficit irrigation to wheat on raised bed

The experiment was conducted during *rabi* season, 2015-16, at the Regional Agricultural Research station of BARI, Ishurdi, Pabna to find out the water requirements of wheat on raised bed and to relate soil moisture content with the progression of the crop season. This study consists of the treatments T_1 = Irrigations up to 100% FC at CRI, booting and grain filling stages (flat land), T_2 = Irrigations up to 100% FC at CRI, booting and grain filling stages on raised bed, T_3 = Irrigations up to 80% FC at CRI, booting and grain filling stages on raised bed and T_4 =Irrigations up to 60% FC at CRI, booting and grain filling stages on raised bed. The experiment was laid out in a RCB design with three replications. The result showed that a significant effect of irrigation treatments on plant height, spike per m^2, grains per spike and grain yield. The highest grain yield (4.91 t/ha) was obtained from treatment T_2, irrigations up to 100% FC at CRI, booting and grain filling stages on raised bed which used 301 mm of seasonal water over irrigation up to 100% FC at same stages on flat land where 308 mm of seasonal water was used.

On raised bed, highest grain yield (4.14 t/ha) was obtained with 80% deficit irrigation at the expense of 288 mm of water. However, irrigation up to 60% of field capacity used a seasonal water of 277 mm and produced a yield of 3.38 t/ha with no significant difference with that irrigated at 80% of FC. On comparing raised bed to flat land wheat yield at full irrigation condition increased about 19% to 23.68% with 10.31% saving of irrigation water. With 20% deficit irrigation, theuse of water was reduced by 22.86% while yield was increased 4.28%. But at 40% of full irrigation, water use was reduced by about 29.14% whereas the yield was decreased by about 14.86%. The rate of daily evaporation was found to vary directly with the rise of temperature and decrease in humidity during the crop season. On comparing the results of raised bed wheat cultivation with conventional farming techniques, it was found that yield increased about 19% to 23.68% and water saved to 10.31%. Besides, under deficit irrigation (20% and 40% of full irrigation), water use on rasid bed could be reduced about 22.86% to 29.14%. It was found that wheat cultivation on raised bed consumed less water than that of flat land and the maxium water use efficiency/water productivity was obtained for wheat cultivation on raised bed with irrigations up to 80% field capacity at CRI, booting and grain filling stages.

Effect of irrigation and mulch on the yield of maize in southern areas of Bangladesh

This study was conducted at the farmer's field of Babugong Upazilla, Barisal to determine the effect of irrigation sequences and straw mulch on the yield of maize. The experiment consisted of two factors:

irrigation and mulch. The irrigation treatments were placed in the main plot as: I_1: Farmer practice, I_2: One irrigation at 4 leaves stage, I_3: Two irrigations each at 4 leaves stage and 8-10 leaves stage, and I_4: Three irrigations each at 4 leaves stage, 8-10 leaves stageand tasseling stage. The sub plot treatments were: M_1: No mulch, M_2: Mulch with 1 cm thickness, M_3: Mulch with 2 cm thickness, and M_4: Mulch with 3 cm thickness. The variety of test crop was BARI Hybrid Maize-9. I_4 (Three irrigations each at 4 leaves stage, 8-10 leaves stage and tasseling stage) produced the highest plant height (274.3 cm) stating that plant height is directly proportional to water availability but the quantity must not not exceed the optimal quantity. From two years observations, I_3M_3 (Two irrigations each at 4 leaves stage and 8-10 leaves stage with 2cm thick mulch) produced the highest number of grain per cob and 100-grain weight. The highest grain yield and biological yield were also obtained from I_3M_3 over two years of observations. Among all treatments, I_3M_3 (Two irrigations each at 4 leaves stage and 8-10 leaves stage with 2cm thick mulch) produced the highest BCR (1.70). From the observations, farmers' practice, I_4 (Three irrigations at 4 leaves stage, 8-10 leaves stage and tasseling stage) produced the highest plant height (274.3 cm) which indicated that the plant height was directly related to the amount of applied water and I_3M_3 (Two irrigations at 4 leaves stage and 8-10 leaves stage with 2cm mulch) produced the highest number of grain per cob and 100-grain weight. Thus, from this study it is revealed that two irrigations at 4 leaves stage and 8-10 leaves stage with 2cm mulch are the best options for optimal yield of the selected maize variety, BARI hybrid Maize 9 (BHM-9).

Determination of crop co-efficient values of soybean by lysimeter study

The experiment was conducted during 2015-2016 crop season on soybean (variety BARI Soybean-6) from mid-November to the last week of March in a lysimeter (dimension: 1 m X 1 m X 1 m size) installed in the experimental field of Irrigation and Water Management Division of BARI which measured the daily evapotranspiration (ET_c) of soybean. The crop coefficient (K_c) value was then determined with the help of this ETc values in conjunction with reference crop evapotranspiration for the location and the crop growth stages. The study was conducted with four levels of irrigation at an interval of 10, 15, 20, and 25 days allowing drainage within and adjacent of four lysimeter tanks. Irrigation at 15 days interval produced the highest seed yield and was considered to be suitable for estimating ET_c and K_c. Seasonal highest ET_c was found at 371.18 mm. The reference crop evapotranspiration was estimated from climatic data using the Software, CROPWAT. The K_c values of soybean at initial, development, mid-season and late season were found to be 0.67, 1.46, 1.59, and 0.62. These values were found somewhat higher than the value recommended by FAO. The Kc values determined under this study are location specific and it is quite understandable that the global average values should differ from these values.

Effect of water stress at different growth stages on the yield of mustard

This experiment was carried out at BARI, Gazipur, and at the farmer's field of Shympur, Rajshahi during the rabi season of 2015 - 2016 with BARI Sarisha-14. There were five irrigation treatments, each replicated thrice in a randomized complete block design. Basin irrigation method was used. It was found that deficit irrigation (DI) utilized less seasonal water to produce the highest yield, water productivity, percentage water saved, and net return compared to full irrigation. This irrigation reduced some plant growth (biomass and LAI) compared to full irrigation. Seasonal water use and WP were found to be 107.05 mm, 116.05 mm, 1.58 kg/m^3 and 1.23 kg/m^3 by applying deficit irrigation at 80% of FC ($DI_{80\%}$) at pre-flowering stage for Gazipur and Rajshahi, respectively. This treatment saved more than 50% water to produce 1.58 t/ha in Gazipur and 1.23 t/ha yield in Rajshahi. This treatment also gave the highest net return of 1.94 lakh and 1.74 lakh Tk. per ha of land in Gazipur and Rajshahi, respectively. From this study, it can be said that BARI Sarisha-14 with deficit irrigation of 80% FC ($DI_{80\%}$) at pre-flowering stage can produce the highest yield in locations of water scarcity if soil moisture is at the optimal sowing condition. From the deficit irrigation at 80% field capacity in pre-flowering stage utilized less seasonal water to produce the highest yield, water productivity, percent of water saved and net return compared to full irrigation. However, this treatment reduced growth parameters of biomass and leaf area index to some extent compared to full irrigation at pre-flowering and pod formation stages. This single irrigation can be optimum for getting satisfactory yield of BARI Sarisha-14 if crop is planted in optimal soil moisture condition during rabi season. Besides, due to single irrigation, this crop can complete its cycle within 80 days of sowing.

Response to available soil moisture on the growth and yield of chickpea

The experiment was conducted in the experimental field of IWM Division, BARI, Gazipur and in farmer's field of Godagari, Rajshahi during 2015 -2016 to investigate the response of available soilmoisture on the growth and yield of chickpea. Four levels of irrigation were applied to crop field with four replications. Treatments were $T_{1=}$ Rainfed, $T_{2=}$ one irrigation (light irrigation of 1.0-1.5 cm) at post-sowing, $T_{3=}$ one irrigation (light irrigation of 2-3 cm) at pod development (80-85 DAS) stage, and $T_{4=}$ Two irrigations each at post-sowing and pod development (80-85 DAS) stages. The results showed that most of the yield parameters were found to give higher values in treatment T_2 and T_4. The growth parameters like root length, shoot length, and biomass were found to have positive response to seasonal water use. The rainfed treatment was found to have the least response to these parameters. The soil moisture of treatment T_2 was found higher than that of any other treatment from vegetative stage to pre-flowering (50 DAS) stage in Gazipur. It was also observed that treatment T_1 produced comparatively less biomass than treatment T_2. The treatment T_2 gave the highest seed yield in both the locations at Gazipur (1.55 t/ha) and at Rajshahi (1.33 t/ha), where a post sowing irrigation (light irrigation of 1-1.5 cm) was applied. However, chickpea (BARI Chola-9) responded well to different soil moisture regimes. Two irrigations increased plant growth (root length, shoot length and canopy coverage) but decreased yield compared to that under rainfed condition and single irrigation. Rainfed treatment produced the lowest growth and yield. Single irrigation (light irrigation of 1-1.5 cm) at post sowing stage was found to produce better yield than any other irrigation option. Thus, it can be concluded that vegetative stage was the most critical stage to irrigation. A single irrigation just after sowing seeds was found to produce better economic return than any other option.

Testing of aquacrop model in simulating yield response of maize to full and deficit irrigation conditions in Bangladesh

Accurate crop models are important tools for predicting crop yields to optimize irrigation under limited available water for enhanced sustainability and profitable crop production. The FAO Aqua Crop model predicts crop productivity, water requirement, and water productivity under water limiting conditions. The performance of AquaCrop model was evaluated for maize using data from a field experiment conducted in the research field of IWM Division, BARI, Gazipur, Bangladesh during winter season of 2015-2016 with different irrigation scenarios. The model predicted the aboveground biomass and grain yield with acceptable accuracy under rainfed, full and deficit irrigated conditions. The predicted values of final aboveground biomass were about 16.0% of the measured values while the predicted maize grain yields were 6.54% of measured values, except in the rainfed treatment.The results showed high goodness of fit between the observed and the simulated biomass yield for all treatments with index of agreement (d) values ranged from 0.96 to 0.98, root mean square error (RMSE) from 1.11 to1.26 t/ha and model efficiency (E) from 0.96 to0.98. High reliability of Aqua Crop for the simulations of grain and biomass yield implies that, it can be used as a valuable tool for estimating crop productivity under various irrigation strategies.

Effect of alternate wetting and drying furrow irrigation on the yield and water productivity of maize

A new method of irrigation was used to investigate the effect of alternate furrow irrigation on crop performance , seasonal crop water use (SCWU), water productivity (WP), and nutrient uptake concentration in grain of maize (BARI hybrid maize-9) at Irrigation and Water Management research field, BARI, Gazipur and Agricultural Research Station, BARI, Dinajpur. The field experiments were laid out in randomized complete block design in spilt plot with nine treatments replicated thrice. The treatments were accommodated by three irrigation levels and the same number of irrigation methods (Irrigation water applied to 100% (I_1), 80% (I_2) and 60% (I_3) field capacity. Alternate wetting and drying furrow irrigation(AWDFI), fixed wetting and drying furrow irrigation (FWDFI) and traditional furrow irrigation(TFI) methods, respectively, denoted by M_1, M_2 and M_3). Results showed that AWDFI produced similar grain yield compared to TFI with almost 37% reduction in irrigation water when irrigated to 100% FC. The interactive effect of irrigation levels and methods had significant effect on dry matter (DM) and grain yield productions among the treatments while the same level of irrigation produced insignificant difference between the treatments, AWDFI (M_1) and TFI (M_3) methods. AWDFI (M_1) and TFI (M_3) obtained significantly better dry matter and grain yield compared to the FWDFI (M_2) method. On an average, AWDFI and TFI produced around 8.13 t/ha and 8.10 t/ha, respectively, in Gazipur and 9.74 and 9.98 t/ha in Dinajpur, respectively, over two years (2015 and 2016) when irrigation water was applied to 100% field capacity. AWDFI saved 37, 34 and 31% seasonal crop water use (SCWU) at Gazipur and 32, 29 and 24% SCWU at Dinajpur compared to TFI over two years of 2015 and 2016, when irrigation water was applied to 100, 80 and 60% FC, respectively. WP was substantially improved by AWDFI. WP was higher around 38% in Gazipur and 31% in Dinajpur in AWDFI system than TFI over two growing seasons of 2015 and 2016when irrigating with 100% FC.The micronutrients (N, P, K. S, Ca, Mg) and micronutrients (B, Zn, Cu, Fe, Mn) concentrations in maize grain were found similar trends in the methods of AWDFI, FWDFI and TFI when irrigated with the three irrigation levels of I_1 (100% FC), I_2 (80% FC) and I_3 (60% FC), respectively.

Alternate wetting and drying furrow irrigation (AWDFI) has the potential to improve both yield and seasonal crop water use. On average, AWDFI and TFI with irrigation amounting to 100% field capacity produced maize grain yield around 8.13 and 8.10 t/ha, respectively in Gazipur and 9.74 and 9.98 t/ha in Dinajpur over two years of 2015 and 2016. Compared to the TFI, AWDFI technique saved 37% seasonal crop water use (SCWU) at Gazipur and 32% SCWU at Dinajpur over two years of 2015 and 2016 when irrigation water was applied up to 100% FC. The concentrations of macro and micro-nutrients in maize grain at harvest were found to have similar trend among the methods of alternate wetting and drying furrow irrigation, fixed wetting and drying furrow irrigation and traditional furrow irrigation under the irrigation levels of I_1, I_2 and I_3, respectively. However, alternate furrow irrigation may be used in practice by alternately irrigating one part of the root zone of the plant each time and may improve water productivity of maize crop without significant yield attributes and yield reduction.

Growth and yield of sweet orange as influenced by timing of fertilizer application and method of irrigation

The study was carried out at the experimental field of Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur to determine the appropriate timing of fertilizer application and the irrigation method on the growth and yield of sweet orange. The experiment was designed with five treatments and five replications. The treatments were: T_1 = Rainfed (normal practice), T_2 = Irrigation at 10 days interval by ring basin method (November-May) with recommended fertilizers applied two times in a year, T_3 = Irrigation at 15 days interval by ring basin method (November-May) with recommended fertilizers applied four times in a year, T_4= Drip irrigation at five days interval (November-May) with fertilizer application at two months interval, T_5 = Drip irrigation at five days interval (November-May) with fertilizer application at once in a month. Results of this study indicated that the plant height and stem diameter were observed greater in treatment T_4 than other treatments. Yield contributing parameters (fruit length and diameter) and total yield were found to have almost similar trend of T_2, T_3, and T_4 but higher than T_1 and T_5. The treatment T_4 with drip irrigation at five days interval with fertilizer application at two months interval performed better in plant growth than other treatments. Seasonal irrigation water use was lower in treatment T_4 and T_5 than T_2 and T_3 in each year. Drip or ring basin method could be an irrigation strategy for sweet orange cultivation due to better plant growth, number of fruits, fruits length and diameter, yield and water use. However, this is an on-going study, and for the third time, excellent bearing is being observed during the year of 2016. Definite conclusions may be drawn after the completion of the study cycle.

Effect of alternate furrow irrigation on growth, yield, quality and water productivity of potato

Alternate furrow irrigation (AFI) was studied on potato cultivation at the research field of Irrigation and Water Management Division under Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during *rabi* season of 2015-2016 to assess the dry matter, tuber yield, water productivity (WP) and N, P, K, Zn, B and total soluble solid (TSS) contents in tubers in respect of irrigation levels and methods. Therefore, a factorial field experiment was conducted as a randomized complete block design with six treatments replicated thrice. The treatments onsisted of two irrigation levels and three furrow irrigation methods. Two irrigation levels were (i) I_1: Irrigation at stolonization (20-25 DAP), tuberization (40-45 DAP) and at tuber enlargement (60-65 DAP) stages, (ii) I_2: Irrigation at 12-15 days interval. Three irrigation methods consisted of (i) alternate furrow irrigation (AFI), (ii) fixed furrow irrigation (FFI) and (iii) every furrow irrigation (EFI). Results showed that dry matter and tuber yield of potato did not differ significantly between the treatments, AFI (tuber yield: 22.65 t/ha) and EFI (tuber yield: 24.27 t/ha), but significant difference was observed when AFI and EFI were compared to FFI (tuber yield: 20.02 t/ha). AFI saved irrigation water by 35% compared to that of EFI. WP was substantially improved in AFI (by 33.6%) compared to EFI when irrigation was applied at 15 days interval. Nutrients, N, P, K, Zn and B content in tubers were found similar in AFI and EFI. Tuber quality in respect of TSS was found to be non-significant in AFI (6.3 ^{0}Brix) and EFI (6.63 ^{0}Brix) under the irrigation level of I_1. However, AFI is also a useful water-saving irrigation technique which may be as an alternate choice compared to EFI in the areas where available water and supply methods are limited to irrigation.

Growth, yield and quality of mandarin and sweet orange as influenced by different methods and levels of irrigation

The experiment was conducted at RARS, Akbarpur, Moulovibazar on existing orchard to investigate the effect of different methods and levels of irrigation on the growth, yield and quality of mandarin and sweet orange. from December 2013 to April 2016. Kamala lines 26,27and BARI Malta-1 wereusedasthetestcrops.The experiment was conducted with 6 years (orange) and 4 years (sweet orange) old plantation. The four treatments were distributed in a randomized complete block design with four replications. The plant spacing was 4mx4m for orange and 3.5mx3.0m for sweet orange. The treatments were T_1: Rain fed, T_2: Irrigation applied at 10 days interval by ring basin method, T_3: Irrigation applied at 15 days interval by ring basin method, T_4: Irrigation applied through drip system at 3 days interval. Measured amount of water was applied to each plant at several intervals to maintain the soil moisture content at the root zone. In irrigated orange and sweet orange plants, growth was found better than non-irrigated plants. The result revealed that most of the parameters were higher in treatment T_4 where drip irrigation was applied. The highest (1553 kg/ha) and the lowest (501 kg/ha) yields of orange were obtained from treatments, T_4 and T_1, and in sweet orange, 8449 kg/haand2335 kg/ha, from the treatments T_4 and T_1, respectively. The highest yield was obtained from treatment T_4, (Drip irrigated treatment) which resulted in higher water productivity (5.55 kg/m^3 for mandarin and 12.83 kg/m^{3}for sweet orange) but the minimum values were obtained from ring basin irrigation method (2.43 kg/m^3 for orange and 6.49kg/m^{3}for sweet orange). The higher BCR was also observed in drip irrigated treatment (T_4). So drip irrigation is a suitable method for mandarin and sweet orange in plane as well as in hilly areas for achieving higher crop water production.

Effect of irrigation amount and frequency on the growth and yield of onion under sprinkler irrigation

The effect of sprinkler-irrigation with 60, 80, 100 and 120% ETc regimes at the frequencies of 6-, 9- and 12- day intervals was investigated for onion (Allium cepa) grown on sandy loam soil in the Research field of IWM Division, BARI, Gazipur during November 2015 to March 2016. All frequencies of a particular irrigation treatment received the same amount of irrigation water throughout the season. Results showed that both irrigation regime and irrigation frequency caused a significant ($P \leq 0.05$) variation in bulb yield of onion. Irrigation frequency at 12- day interval produced the lowest bulb yield at all levels of irrigation regimes, so should be avoided for onion crops. Irrigation at 6- and 9-day interval produced the higher yield comparable to each other. Deficit irrigation regimes (60% ETc and 80% ETc) gave the better results under 9-day frequent irrigation than under 6-day frequent irrigation. This was reverse in case of higher water regimes. Bulb yield increased significantly at each irrigation level from 60% ETc to 100% ETc; however from 100% to 120% ETc the increase in yield was insignificant. Thus irrigation at 6-day interval with 120% ETc produced the highest bulb yield of 15.27 t/ha, while the second highest yield of 14.87 t/ha occured at 100% ETc irrigation regime at 9-day interval.

In all cases, 12-day frequent irrigation resulted in lower yields than other irrigation frequencies. WUE ranged between 6.32 and 7.41 kg/m^3 for 6-day frequent irrigation, between 6.76 and 7.91 kg/m^3 for 9-day frequent irrigation with maximum value in 80% ETc and minimum value in 60% ETc. Irrigation frequency at 12-day resulted in poor WUE ranged from 4.58 kg/m^3 for 60% ETc to as much as 6.72 kg/m^3 for 100% ETc as water supply at longer interval leads to lower yields than 6- and 9-day frequent irrigations. Therefore, water supply at 6-day interval with 120% ETc water regimes or at 9-day interval with 100% ETc can be practiced for getting higher yield of onion as these options better adapted to the plant requirements during the whole growing season because it results in reduced drainage and better use of the water by the crop.

Technical and economical feasibility of solar pump irrigation for crop cultivation in comparison with other power sources

Solar powered water pumping system plays an important role in irrigation and water management. It is necessary to compare the economic and technical feasibility for crop production to develop data base for irrigation experts, policy makers, farmers and private entrepreneurs and water management. Therefore, this study was undertaken to assess the technical and economic analysis of solar, diesel and electric powered water pumping for irrigation at different locations in Bangladesh. Primary and secondary data were collected through field survey, monitoring and questionnaire survey in 2015 and 2016. A total of 12 samples for solar powered irrigation system, 2 samples for solar powered irrigation with household electrical-grid supply system, 4 samples for electric powered irrigation pump systems and 4 samples for diesel powered irrigation pumping system were randomly selected for this study. Other information was gathered from national and international experiences, and related past literatures. Five case studies (two solar powered, two electric powered and one diesel powered irrigation system) were randomly selected for details economic analysis to assess and compare the benefit cost ratio (BCR), internal rate of return (IRR) and net present value (NPV).The survey study indicated that the cost of pumped irrigation water using panels of solar photovoltaic cells with accessories was between Tk 2,413,010 and Tk 5,500,000 with the panel capacity range from 4.2 kW to 14kW. In contrast, diesel powered pumping units of capacities between 2.98 KW and 4.48 KW cost Tk 25,000–Tk 35000.The costs of electricity powered pumps of capacities, 3.73 KW to 18.65 KW cost Tk 120,000 – Tk 1,000,000.

The highest gross margin was estimated from electric powered irrigation compared to solar and diesel powered irrigation system for various crops cultivation, while lower gross margin was estimated from diesel powered irrigation pumps due to lower gross irrigated area for crop production. Among the case studies, BCR was found 0.10 and 0.05 in solar powered irrigation and solar powered irrigation with household electrical-grid supply system, respectively. IRR and NPV were found negative which indicates that these systems are not economically profitable.BCR, IRRand NPV were found highest 1.39, 44% and Tk 2,00,511 in electric powered irrigation (centrifugal pump) system compared with other power sources, which indicates that this system is profitable. Based on existing farmers' field condition, as is evident by now, solar powered irrigation pumping systemsrequire high initial costs. However,an economic evaluation of solar powered system could be considered in future for its multipurpose uses such as, solar-cum-diesel powered irrigation pumping system for crop production and drinking water supply, electrification to villages for providing lighting, fans and lighting at street, water supply for fish culture and other community services like as telecommunication.

Constraints

- Installation cost is very high and highly technical
- Pumping is not possible in cloudy and foggy weather
- Irrigation is not possible during night
- Command area is very low due to lack of underground water conveyance system
- Water surcharge for solar pumps is almost equal to diesel pumps and sometimes higher than electrified pumps
- Enough space is needed for solar pumps

Prospects

- It can be feasible for drip irrigation systems for high value crops with Govt. subsidy
- It can be suitable for lifting surface water in remote areas with reducing the cost of solar panels
- May be feasible with accommodation of energy storage unit
- Initial cost of installation should be in affordable limit for farmers
- It saves environment

Study the water management for four-crop based cropping patterns in barind area

Water is an important natural resource and its increasing scarcity has resulted into the emergence of various issues for its efficient use, management and sustainability. The demand for water (of appropriate quality) is expected to rise manifold owing to ever increasing population, rising demand for food, urbanization and industrialization and may even exceed its supply. Such a phenomenon will prevail in almost every part of the world, more pronounced in those economies where agriculture occupies a dominant position and accounts for a major chunk of water use (Third World Water Forum, 2003). Ground water irrigation has probably been the most dramatic development in Bangladesh agriculture in the past three decades. In Bangladesh, about 63 per cent of the cultivated area is under irrigation with nearly 80 per cent of the water resources being used for agricultural production of which 78% is coming from ground water. In Barind area, after the development of GW resources through the construction of DTW by BMDA, there has been a rapid increase of boro rice cultivation replacing relatively less water-intensive crops like oilseeds and pulses in the production pattern.

Since then the area under boro rice, a water-intensive crop has been increased substantially. More than 60% of the total cropped areas in Bangladesh are covered by T.Aman-Fallow-Boro cropping sequence (Ladha et al., 2003; Dawe et al., 2004; Bhuyan et al., 2004). Like other part of the country, the dominance of boro rice caused an increased exploitation of ground water that has resulted in a rapid depletion of GW table in Rajshahi region. Besides delayed monsoon, less rainfall under the impact of climate change and drying up of rivers have been contributing to a water crisis and affecting agricultural production in this region. Such a situation threatens the sustainability of water resources and thereby the agricultural productivity, calling for an efficient and sustainable management of water resources (Draft Water Policy, 2004).

Irrigation water availability is a main driver which determines cropping patterns for an irrigated area. In Barind area, water scarcity is the main constraint for year round crop production as well as the sustainability of agriculture. To cope with future water scarcity in the face of climate change, cropping patterns in this area should be changed and adjusted for available water resources. Cropping these lands through proper cropping sequence, together with proper irrigation water management will certainly enhance sustainability of crop production, especially in stressed areas like drought prone barind area of Bangladesh. Recently, BARI has developed four-crop based cropping patterns to increase the farmers' income, cropping intensity, national production and to ensure the sustainability of crop production as well. Although four-crop based patterns seemed to be exhaustive in view of resource conservation (water and nutrient availability, etc.), inclusion of low water requiring crops such as pulse crop in the pattern might be remunerative in terms of both water productivity and soil fertility. This study, therefore, was conducted to find out effective water management practices for four-crop based cropping patterns which will enhance the sustainability of crop production with limited water resources in Barind area. As different crops need different quantities of water for their production, cost effectiveness of using irrigation water for different crops needs to be examined so that the appropriate crops can be grown with adequate profitability. From one year study that inclusion of non-rice rabi crops instead of boro rice can significantly reduce the irrigation requirements in dry season and increase the rice equivalent yield (REY) without having any effect on farm's income.

Impact of irrigation water salinity on growth, yield and water use of wheat

Water and soil salinity are important factors determining crop growth and yield, especially, in the saline soils. A field experiment was conducted at the experimental field of IWM division of Bangladesh Agricultural Research Institute, Gazipur during December- March, 2014-2015 and 2015-2016 to investigate the effect of irrigation water salinity on the growth, yield components and yield of wheat. Irrigation with four fixed levels of salinity (4, 7, 10 and 13 dS/m) and one varying levels (salinity increased as plant grow older) of saline water were compared with fresh water (<0.5 dS/m) irrigated (control) treatment. All the growth and yield components were found negatively affected by irrigation with different levels of saline water. The decreases of growth and yield parameters were not significant up to the salinity of 7 dS/m. Beyond this, a strong negative effect was observed on almost all growth and yield contributing parameters like plant height, rooting density, leaf area index, spike length, spikelet per spike, number and weight of grain per spike, 1000- grain weight and biomass yield. In all cases, the highest values were recorded in control and the lowest were recorded in higher levels of salinity (for 13 dS/m in the first year and 16 dS/m in the second year). Irrigation with saline water of 4 dS/m and fresh water gave identical results in term of growth, yield and yield contributing parameters. Over the years, the highest grain yields of 5.14 and 4.29 t/ha were found in the control treatment and low salinity treatment in the first and second season, respectively, while the lowest yields of 3.58 and 3.03 t/ha were found in the high salinity treatments. On an average, compared to the low salinity level, medium (10 dS/m) and high salinity (13 dS/m) levels reduced the grain yield by 20.65 and 31.72% and biomass yield by 20.1 and 33.0%, respectively. Whereas varying levels of salinity reduced the grain yield only by 10.24% and biomass yield by 15.88%. The water use by the crop ranged from 204 to 258 mm in the first season and 212 to 283 mm in the second season with maximum in no salinity treatment and minimum in high salinity treatment. Applying varying level of salinity gave almost similar results in terms of growth, yield and yield components with 7 dS/m salinity level. This treatment gave the highest water productivity of 1.70 and 1.88 kg/m^3 in the first and second seasons, respectively, with 223 and 243 mm of total water use. Therefore, irrigation with low saline water at the early growth stages and higher salinity water at the later stages might be a good option for growing wheat in saline areas where fresh water availability for irrigation is very scarce.

Conjunctive use of saline and fresh water for crop irrigation

An experiment was conducted at the Agricultural Research Station, Benerpota, Shatkhiraof Bangladesh Agricultural Research Institute during rabi season of 2015-2016 to investigate the response of mustard and maize to conjunctive use of saline and fresh water for irrigation. Groundwater with marginal salinity of ≤1.8 dS/m was considered as fresh water, whereas the nearby canal water of salinity, 4.6-7.2 was considered as saline water. For mustard there were four irrigation treatments, on the other hand five irrigation treatments were set for maize. For both the crops the number of irrigations, crop growth stages, and sources of irrigation water were varied among the treatments. The experimental results showed that different irrigation treatments had statistically non-significant effect on yield attributing parameters (Plant/ m^2, plant height, no. of branches/ plant, no. of pods/ plant, no. of seeds/ pod, and 1000 seeds weight) of mustard. Except the number of plant/ m^2, all other yield attributes were found maximum for treatment (T_2) with one irrigation at vegetative (25-30 DAS) stage with fresh water and another irrigation at pod formation (50-55 DAS) stage with saline canal water (traditional practice). However, the values of yield parameters were not much lower in treatment (T_3) with fresh water irrigation at vegetative (25-30 DAS) stage and saline canal water irrigation at pod formation (50-55 DAS) stage. The yield values of these two treatments were also very close. Seed yield and straw yield of mustard were 1.567 t/ha and 3.850 t/ha, respectively, in T_2, whereas the corresponding values in T_3 were 1.503 t/ha and 3.567 t/ha. Yields of the mustard were significantly reduced in treatment with single fresh water irrigation, and in treatment with two saline water irrigation. Yield attributes of maize also did not vary significantly among different irrigation treatments. Plant height, number of cob/ plant, number of grain/ cob, and 1000 grain weight were found the highest in T_2which was irrigated with fresh water at vegetative (40-50 DAS), tasseling (75-80 DAS) and grain filling (110-120 DAS) stages. . However, some of the yield parameters, such as number of plants/ m^2, cob length, cob diameter, as well as straw yield were found maximum in treatment, T_4, irrigated at vegetative (40-50 DAS) stage with fresh water and at tasseling (75-80 DAS) and grain filling stages (110-120 DAS) with saline canal water. Although grain yield was maximum in T_2 (8.01 t/ha), its second highest value was obtained in T_4. Again, the yield values were reduced as the number of irrigation reduced and/or saline water was applied in early crop stage. The obtained results for both mustard and maize clearly indicate that the moderately saline canal water can be a very handy source of irrigation water for rabi crops, when fresh water is relatively scarce. Instead of reducing the number of irrigation events, freshwater irrigation at sensitive stages combined with saline canal water irrigation at later stages can minimize yield loss for moderately saline tolerant crop varieties. For both of the crops, an early irrigation with freshwater improved crop yields significantly rather than that of using saline water in all of the stages.

Performance of advanced grasspea genotypes/varieties under different levels of irrigation water salinities

This study was conducted in plastic pots in the polyhouse of Irrigation and Water Management (IWM) Division at Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during 2014-2015. A total of 5 (five) grasspea genotypes and 1 (one) variety were considered as cheek for trial. Three (3) levels of salinities i.e. 4 dS/m, 8 dS/m, and 12 dS/m were considered in irrigation water. Among the six genotype/varieties, 2 (two) of them i.e. SEL-1348 and BKX-002-4 performed well upto salinity of 8 dS/m. Among the two genotypes, SEL-1348 performed very well (69.92 g/plant at 4 dS/m and 45.55 g/plant at 8 dS/m). The genotype, BKX-002-4 produced some less yield per plant (41.51 g/plant at 4 dS/m and 36.67 g/plant at 8 dS/m) than those of genotype, SEL-1348. The two promising grasspe genotypes SEL-1348 and BKX-002-4 performed well against the irrigation water salinity upto 12 dS/m during the screening of 2014-15 in pot culture. These two genotypes can be tested in saline soils in up coming season.

Screening of summer chilli variety/line against water-logging

The study was conducted at Irrigation and Water Management research field, BARI, Gazipur during summer season of 2015 to screen out water- logged tolerant chilli variety/line and to find out the critical stages of summer chilli to water-logged condition. A factorial field experiment was carried out as a randomized complete block design with eight treatments replicated thrice. The treatments consisted of two durations of water-logged levels, I_1 (8 hours) and I_2 (12 hours) at flowering and fruit setting stages of summer chilli. Four varieties/lines were, V_1: BARI Morich-1, V_2: BARI Morich-2, L_1: C-517and L_2: C-590. The results showed that the summer chilli plant was found more sensitive to water-logging at flowering stage (34 days after planting). Among the varieties and lines, the line L_1 (C-517) produced better fruit yield while the variety, V_2 (BARI Morich-2) produced significantly lowest fruit yield when water-logged level was I_1 (8 hours) and I_2 (12 hours). The marketable fruit yield was obtained similar to L_1 (C-517) and V_1 (BARI Morich-1). L_1 produced around 565.8, and 432.5 kg/ha and V_1 produced 669.6, and 675.4 kg/ha, respectively, while the lowest yields were obtained as 256.2 kg/ha and 264.5 kg/ha from V_2 (BARI Morich-2) when water-logged level was I_1 (8 hours) and I_2 (12 hours), respectively. The line L_1(C-517) showed better performance among the varieties/lines and it seems to be a promising line in summer season. The line could produce better number of fruits, fruit weight per plant and fruit yield under water logged conditions upto 8-12 hours. This is an ongoing study, after 2 or 3 crop cycles, the conclusion can be drawn.

Sustainable crop production in drought and saline coastal areas of bangladesh under changing climate

The project aims to develop some suitable water management practices for major cropping patterns in saline and drought prone areas of Bangladesh under climate change situation. The coastal districts selected for conducting cropping pattern based experiments were Barguna, Khulna and Satkhira, and the drought prone districts were Kushtia, Rajshahi and Rangpur. Every crop in major cropping patterns of that area received four different water management practices varied according to crops. From the experiments conducted during 2014-2015, it was seen that non-rice dominant cropping pattern had lower water use with higher water productivity (WP). In salt prone areas, both rice equivalent yield and water productivity were found higher in T_2 water management where modest amount of water was applied through irrigation, while in drought prone areas though the higher WP was obtained mostly from T_2 irrigation management, the highest rice equivalent yield (REY) was obtained from T_4 irrigation practices where higher amount of water was applied through irrigation. In saline prone area, Tomato-Jute-T.Aman had the highest REY (54.60 t/ha) and WP (5.73 kg/m^3) followed by Tomato-T.Aus-T.Aman (REY: 41.51 t/ha and WP: 2.85 kg/m^3) and Watermelon-T.Aus-T.Aman (REY: 38.21 t/ha and WP: 2.74 kg/m^3) for T_2 water regime. Total water use was found the lowest in Mustard-Mung-T.aman and Wheat-Mung-T.aman patterns. The highest water used pattern was Mustard-Boro-T.Aman with lowest water productivity of 0.72-0.86 kg/m^3. On the other hand, in drought areas, the highest REY and WP (56.60 t/ha and 3.94 kg/m^3, respectively) were obtained in Tomato-T.Aus-T.Aman pattern. Total water use was also found higher in this pattern and ranged from 1437 mm to 1780 mm depending on irrigation management. In general, total water use (TWU) was lower in non-rice dominant pattern than rice dominant pattern. REY and WP increased drastically when some non-rice crops like tomato, potato, watermelon and even jute were included in the pattern. Among the pattern, the highest gross margin (TK.649704/ha) and the BCR (3.21) were obtained from Tomato- Jute-T.Aman under T_4 water management and the lowest values (Tk. 57604/ha and 1.44, respectively) were obtained from Wheat-Mung-T.aman cropping sequence under T_2 water management in saline prone areas. While in the drought prone area, the highest gross margin (Tk. 751102/ha) and the BCR (4.28) were obtained from Tomato-T.Aus-T.Aman in T_3 water management and the lowest values (Tk. 43520/ha and 1.39, respectively) were obtained from Chickpea-Mung-T.aman cropping sequence in T_1 water management. In both the areas, not a particular water management option was suitable for a particular crop and/or cropping sequences for getting higher yield and profit as well.

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Adoption of two wheel tractor operated seeder in rice-wheat cropping system

Two wheel tractor which is generally called power tiller in Bangladesh. Power tiller operated seeder (PTOS) sometimes called as minimum till seeder and it is being used for different crops seeding along with seed bed preparation. It works as shallow tilling, fertilizing, seeding in line, seed covering and land leveling at a time maintaining the standard agronomic practices. It tills upper part of the soil which is less than 15% of tilling zone. The seeder was demonstrated in different locations in the farmer’s field of Dinajpur, Thakurgaon, Tangail, and Rajshahi area in 2015-16. Recommended basal dose of fertilizers were broadcasted over the land surface before seeding operation. Some cases granular composite fertilizer like DAP was applied through machine during seeding operation. During pulses seeding, TSP was applied along with seeding operation through the machine. Wheat, maize, and lentil were planted after rice harvest and mungbean, sesame were planted after wheat harvest. The density of rice residue was 0.8-1.4 t/ha. The seeder performed seeding operation minimizing 7-9 days turn around time utilizing the residual soil moisture. It maintained uniform seeding depth, uniform seed distribution and better seed soil contact which transfer soil moisture to seeds quickly for enhance better plant establishment and yield. Application of irrigation water was faster than that of conventional method. Minimum tillage saved irrigation water for wheat and maize 14.9% and 4.8%, respectively compare to traditional irrigation method of crop cultivation. Average wheat yield was 20-25.5% higher than that of conventional method. Effective field capacity of the seeder was 0.13 ha/h. Cost of wheat seeding was Tk.1950/ha which was 65.8% less than conventional method (Tk.5695.0/ha). This seeder covers about 4399 ha land in Rajshahi, Tangail, and Dinajpur area. Long term on station trial (7 years), wheat yield in minimum tillage by PTOS showed higher than conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% crop residue. No yield reduction trend observed over the time compare to conventional method.

Adoption of two wheel tractor operated bed planter for upland crops

Adaptive trials of two wheel tractor operated bed planter were conducted in the farmers' field of Rajshahi, Tangail, and Rangpur area in 2015-16. The bed planter was improved and fine tuned with the introduction of operator’s seat, attachment of especial size pulley for rotary speed increase and introduction of inclined plate seed metering device for planting small to large sizes seeds. The operator can drive the planter in ridding position. It solved the problem of long distance travel and enhance adoption considering the added advantage of easy comfortable operation. The size of pulley was 8.5” (216mm). Power transmission chain of the bed planter was divided into two parts avoiding shaking of chain during overcome land boundary (aiel). Both the Dongfeng and Sifeng type bed planter are now available in our country. The implement comprises of four major components, namely- rotary tilling part, furrow opener, seeding unit with metering mechanism and bed former-cum-shaper. Performance of the bed planter was tested for wheat, maize, mungbean and rice cultivation. The uniformity of maize seed spacing was 86-95%. The density of rice and wheat residue were 1.8 t/ha and 1.6t/ha in the tested plot, respectively when seeding on permanent bed. After initially forming the bed, an additional advantage was that reshaped bed can be used for next crop without any further tillage operation keeping it permanent. Fresh bed saved 21.5% and permanent bed saved 34.1% irrigation water over conventional flood method of irrigation with less number of labour involvements. Water logging problem can be avoided introducing bed planting system, especially in rainy season crops. Bed planting allows earthing up, so no need sub sequent earthing up in maize cultivation. Bed planting saved 44% tillage cost compare to conventional method. Maize planting cost in new bed and permanent bed was 63.0% and 72.5% less than conventional seeding method. Average wheat and maizeyields were 3.9 t/ha and 9.8 t/ha, respectively. The same wheat and maize yield in conventional method were 2.9 t/ha and 7.5 t/ha, respectively. Yields of wheat and maize increased by 34% and 30%, respectively over conventional method. Long term on station trial (7 years), wheat yield under bed planting showed higher than that of conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% crop residue. Net return for wheat cultivation in fresh bed and permanent bed planting were 1.9 times and 1.8 times than that of conventional method. The bed planter is now using as custom hire basis in the farmers' field.

On farm validation of two wheel tractor operated zero tillage planter for up land crops

Two wheel tractor (Power tillers) are the common means of soil tillage and other farm operations in Bangladesh due to easy access in fragmented land size with affordable price. The zero till planter is a pull type implement which hitched with tiller at the drawbar point replacing the regular tilling part of it. The validation trials of zero-till planter were conducted in the farmer's field in Rajshahi areas for wheat, maize and pulses establishment during the year of 2015-2016. The planter can pull 4 tynes in soft and medium hard soil but 3 tones for hard soil. The planter was capable to apply seed and fertilizer in an opening slit of width 30 mm and depth 60 mm. Lower speed (2.5 km/h) was comparatively better for seed placement into the opening slit. The planting depth, row spacing and seed rate can be adjusted according to standard practices. Depending on the level of weed situation, round up herbicide was applied 2 days before planting to kill the existing weeds. No till crops showed less lodging tendency compare to conventional planted crops. Zero-till saved plant establishment cost 50-65%, and reducing the average turn around time 7-9 days between the two crops. The effective area coverage and planting cost by the seeder was 0.12ha/h and Tk.1900.0/ha, respectively. Long term trial (6 years), zero tillage wheat yield showed continuously higher than that of conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% residue. Fertilizer management, weed control and selection of right crop variety with proper crop rotation are the key issue for adopting this new technology.

Evaluation and extension of two wheel tractor operated potato planter in the farmer's field

A low cost power tiller operated cup type potato planter was developed in Bangladesh Agricultural Research Institute (BARI),Rajshahi which can plant whole tuber potato seeds as well as cut piece potato seeds automatically in furrows at predetermined regular intervals. Potato planter maintains a single row of spacing 600 mm and seed to seed distance 200-250 mm for whole tuber seed and 150-160 mm for cut piece seed. Performance of the planter was evaluated in the farmer's fields to determine the effect of forward speed and seed sizes on the uniformity of spacing and seed missing during 2015-16. Forward speed of 2.4 km/h is the best in respect of uniformity of spacing and missing seeds. Seed sizes of 35mm were found the best in respect of uniformity of spacing (94%) at the speed of 2.4 km/h. Field demonstrations were conducted at on station and the farmer's field of Puthia, Paba, Sibpur, Rajshahi. The average effective field capacity of cup type planter was 0.10 ha/h and missing seed was 3%. Potato planter requires 4 man-days/ha compare to 67 man-days/ha in conventional manual planting method. Potato planting cost were Tk.4804/ha. On the other hand, using whole tuber and cut piece seed, manually potato planting cost was Tk.14,740/ha and Tk.16940/ha. There are no significant yield difference between potato planter and conventional methods. Manufacturers and operator trainings were conducted under the project works. Farmers field day was also conducted near the potato field showing the crops condition of mechanically planted plots and conventional planted plots. Potato planter can save labour requirement of 63 man-days/ha and planting cost Tk. 9936/ha which was equivalent to 94% and 67% saving of labour and planting cost, respectively compare to conventional manual potato planting method.

Performance evaluation of a tractor mounted vegetable transplanter

Transplanting and planting vegetables in traditional way, is of hard job and inefficient activity. A tractor mounted vegetable transplanter was tested in experiment field of Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2015-16. Tomato and cauliflower seedling were transplanting by the transplanter. The treatments were T_1- transplanting by tractor operated vegetable transplanter, T_2- transplanting by hand at transplanter spacing (row to row 60 cm and plant to plant 40 cm), T_3- transplanting by hand at BARI recommended spacing (row to row 60 cm and plant to plant 45 cm). The average field capacity of the machine was 0.091 ha/h. The average depths of placement were found 4.15 and 2.95 cm and missing rate were 2.32% and 0.58% for tomato and cauliflower respectively. There were no significant difference of yields of tomato and cauliflower among the treatments and comparatively similar results were found. This experiment will be continued to the next year for improvement of the transplanter for its better performance.

Field performance of power tiller operated bed planter for garlic planting

Garlic clove planting is one of the most laborious operations. Labor cost is the main component of high production cost of the garlic. Because of the geometrical uniqueness and irregularity of garlic cloves, mechanization of garlic clove planting is very difficult. To overcome price competition against the imported garlic, however, there has been a need of development of a clove metering device and a planting device for the garlic clove planter. Laboratory and field tests were conducted to develop a garlic clove planter. This research was conducted to drop garlic cloves into a soil holes through a inclined plate metering system. A Power tiller driven garlic clove planter has been developed with locally available materials in Spices Research Centre, BARI, Shibganj, Bogra during 2015-16. The garlic clove planter consists of i) Garlic clove hopper; ii) Inclined plate metering device; and iii) Power transmission system. Average garlic clove to clove spacing was found 9.85 cm. Detailed performance of the planter and modification will be evaluated in the next season.

Development of a low cost battery operated rotary type weeder for up-land crop

Weeds are plants which are considered undesirable in agriculture and gardening. The process of removal of these weeds from crops is called weeding. Weeders are mechanical machines which are used for weed removal. A rotary type DC motor operated dry land weeder was designed and developed. Chemical method of weed control is more prominent than manual and mechanical methods. However, its adverse effects on the environment are making farmers to consider and accept mechanical methods of weed control. Manual weeding is common in Bangladeshi agriculture. It is the most widely used weed control method but it is labor intensive. The mechanical weeder is to reduce drudgery and cost which ensure a comfortable posture of the farmer or operator during weeding and increase production. The costs associated with mechanical weeding such as operating cost can be lowered; as such mechanical weeding can represent a viable and cost effective option to majority of medium and small scale farmers in developing countries like Bangladesh. A 3D model of weeder is designed by Solid work 2015 software and fabricated considering methodological steps. For verification of performance of weeder, field study should be conducted in the next year.

Design and development of dry land NPK briquette applicator

Deep placement of NPK briquettes hammered the runoff, fixation, leaching, and volatilization loss of fertilizer. But deep placement of fertilizer is a laborious job and costly. A manually operated NPK briquette applicator for upland crops was developed at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2014-15. The covering part of the applicator was modified to improved its performance during 2015-16. The applicator was modified for deep placement of one NPK briquette by single push. The average depth of placement of briquette was 7-8 cm. Hole coverage was 75-80 % and distance between plant and briquette was 9-10 cm. There was no missing of NPK briquette during laboratory and field tests. Average field capacity of the applicator was 10 decimal/h (depend on fertilizer requirement of crop). There were no significant differences of yields among the treatments. But maximum yields were found in NPK briquette application by hand applicator, which are very similar. It has good response to the NPK briquette application by machine or hand for long duration crops such as chilli, brinjal, tomato, etc. This experiment will be continued to the next year for improvement of the applicator for its better performance.

Improvement and performance evaluation of an axial flow pump

Three sizes of axial flow pumps such as 76 mm (3″), 102 mm (4″) and 150 mm (6″) diameters and each of 4.5 m long were designed, fabricated and tested at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2013-16. The pumps were fabricated with locally available such as MS (mild steel) pipe, MS solid shaft, MS rod, MS sheet, bearing, MS pulley, rubber bush and necessary spares. The operating power for 76 mm, 102 mm and 150 mm pumps were 10.0 hp, 12.5 hp and 14.0 hp diesel engines. All the pumps were tested at the pump testing beds of FMPE Division of BARI, Gazipur for surface water lifting at the heads of 1.0, 2.0, 3.0 4.0 and 4.5 m and pump speeds of 1800-2000 rpm. Discharges of of 76 mm, 102 mm and 150 mm diameter pumps varied linearly from 5.65 to 18.20 L/s, 16.43 to 29.24 L/s and from 40.72 to 66.67 L/s, respectively for variation of head from 1.0 to 4.5 m. For 76 mm, 102 mm and 150 mm pumps, the peak pump efficiencies and brake powers were found for the discharge of 13 L/s, 21 L/s and 46 l/s, respectively. Therefore, 76 mm, 102 mm and 150 mm diameter axial flow pumps were found technically suitable for surface water lifting. These axial flow pumps may be recommended for surface water irrigation in Bangladesh.

Comparative performance evaluation of different manual injector type USG applicators

Different types of Urea Super Granule (USG) applicators performance were tested in three locations at FMPE Research field, RARS Jamalpur, farmer field, Gazipur. The treatments were T_1= Application of USG by the BRRI applicator, T_2= Application of USG by the BARI applicator, T_3= Application of USG by singlr row IFDC applicator, T_4= Application of USG push type IFDC applicator, T_5= Application of USG by hand and T_6= Prilled urea. All the treatments were replicated thrice with RCB design. The applicators were tested for BRRI dhan 28 during 2015-16. The average field capacity of the BRRI, BARI, IFDC single row and IFDC injector type USG applicators were 0.120, 0.124, 0.0456 and 0.040 ha/h respectively. In case of yield, there was no significant difference among the treatment, but comparatively higher yield in BARI double row and IFDC injector type USG applicators. The Benefit cost ratio (BCR) of the BRRI, BARI and IFDC single row USG applicators were 2.75, 2.86 and 1.07 days respectively.

Design and development of a low cost boom sprayer for fruit tree and field crops

A low cost robust power operated boom sprayer has been developed in Farm Machinery & Postharvest Process Engineering Division of BARI Gazipur and all set up installed on a tri-cycle van. Presently, farmers are interested in horticultural crops for high value, comparatively low risk, less hazard, and easy marketing of product compare to field crops. Crop yields are reduced mainly due to attack of pests, diseases and weeds. The developed boom sprayer consists of small diesel engine, high pressure pump, pesticide tank, boom with nozzle, and tri-cycle. The chemicals are sprayed as the most effective and efficient techniques for applying small volume of spray liquid to protect horticultural crops. The boom sprayer was tested for spraying pesticide in fruit trees to produce uniform effective spray pattern using minimum amount of spray materials. The spray boom has hollow nozzle and can spray in tall tree. The effective field capacity of the sprayer was 0.3 ha/h. The field performance of the boom sprayer was found satisfactory at a pressure of 3 bars. The average spray capacity 2.85 lit/min at 3 bar pressure. The power requirement about 4 Hp for operating the pump. Operating cost of garden boom sprayer was Tk. 595/day and foot sprayer was Tk.1029/day, respectively. The entire boom assembly fixed on a rickshaw van behind of the operator seat. It is safe in adverse wind condition. To facilitate convenience operation for the operator, the design of the entire controls provided near the operator. A transparent plastic tank was provided for clear view of pesticide status in the tank.

Development of a low cost two wheel tractor operated potato harvester

A low cost two wheel tractor driven potato harvester has been developed with locally available materials in Farm Machinery & Postharvest Process Engineering Division of BARI, Gazipur to facilitate small farmers to harvest their potatoes at low cost. Local manufacturer can fabricate power tiller driven potato harvester easily. The potato harvester is a semi automatic digging machine consisting of (i) digging blade (ii) Conveyer flat chain (iii) Guide plate and (iv) Power transmission arrangement with a dimension of 900 mm x 850 mm x 950 mm. The field capacity of the potato harvester was 1.2 ha land per day depending on operator skillness. Potato harvester requires labour 21 per ha only instead of 60 labours per ha in traditional manual method. Total cost of potato harvesting by the potato harvester is Tk. 9,835 per ha but manually harvesting cost is Tk.23,600 per ha. Potato harvester saved 58.3% potato harvesting cost and 65% labour requirement compare to traditional manual potato harvesting method. Moreover, there are no potatoes remain under the soil. Potato damage percentage was less than 1.21%. Potato farmers always pass risk of bad weather especially harvesting time. So, potato harvester can cover large areas within short period of time, escape bad weather uncertainty, and sustain potato production stable.

Modification and performance evaluation of a mango harvester

Mango harvester is mainly used for harvesting mango fruits with less drudgery, fatigue on labour, also preventing damage to the tree branches & fruits as compared to manual plucking and tree shaking. A mango harvester was designed and fabricated of Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur to reduce postharvest loss. During 2014-15, the weight of aluminium mango harvester was 4.1 kg whereas it was reduced to 2 kg during 2015-16. Furthermore, the weight of modified bamboo harvester was 1.7 kg and existing bamboo harvester was 1.5 kg. The mango was harvested from different heighted mango trees in different location of BARI campus, Gazipur and RHRS, ChapaiNawabganj.The highest capacity of aluminium harvester was 222 kg/h and modified bamboo harvester was 156 kg/h. When mangoes were harvested by aluminium harvester, 93% of mangoes were found with pedicel length above1-1.5 cm whereas it was 92% for modified bamboo harvester. The initial cost of aluminium harvester was Tk 5800 and it reduced to Tk 2200.The initial cost of modified bamboo harvester was Tk.1000 and existing bamboo harvester was 450. Farmer has to face problem when mango is harvested climbing on a tree because of fitting the clutch lever at the end position of harvester. The experiment will be continued for improvement of harvester in the next year.

Design and development of coconut tree climber

Coconut tree climber is a machine which helps to climb on coconut tree without much human efforts. Now a days most of the human activities are either replaced by the use of machines or other kind of equipments. It is very difficult to climb on coconut tree manually due to the constant cylindrical structure and single stem. In other type of trees there will be branches for holding and to support the climber. Due to the risk involved nowadays very less people are coming forward to climb on coconut trees. A study was conducted in Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur. Gazipur. Primary goal of the study is to design a coconut tree climbing device for farmers and residents and disseminate it through the farmers.

Development of a low cost two wheel tractor mounted mobile maize sheller

Power tiller (two wheel tractor) is a very common tillage tool in bangladesh. A low cost simple power tiller front mounted spike tooth type mobile maize sheller has been developed in farm machinery & postharvest process engineering division of BARI, Gazipur 2015 with a view to easy way shelling maize in the farmers' field of rural areas and eliminating botheration of transportation of traditional maize sheller from place to place. The main components of the sheller are hopper, rotating cylinder, concave, grain delivery out let, shelled cob delivery out let, sheller fixing arrangement, main pulley with power transmission arrangement. It is an anti clockwise rotating cylinder, axial flow type sheller and grain separated with a frictional force between spike tooth and concave. The maize sheller is attached with nuts and bolts in front of the engine base of two wheel tractor (2wt). The operating power of the sheller comes from the fly wheel of the engine of the tractor through 'v" belt pulley arrangement. The average shelling capacity of the mobile sheller is 2.0 t/h, broken kernel 2.2%, and shelling efficiency 97%. The average cost of shelling maize is Tk. 0.22/kg compare to traditional custom hire rate Tk.1.0/kg. The service provider of the two wheel tractor can transport the mobile maize sheller long distance in operator's seating position as it attached with the 2wt which minimized transportation hazard of maize sheller.

Improvement of existing BARI maize sheller for shelling unhusked maize cobs

Hand peeling of maize is common practice before shelling which is laborious and time consuming. An improved BARI maize sheller was designed and fabricated in Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur during 2014-15 for peeling and shelling of maize by the same machine simutanously. During 2015-2016, fabrication of hopper, modification of frame and reducing gear size for roller gap adjustment have been done. This machine has two part in which peeling is done in upper part and husked cobs are delivered to lower part for shelling. Two rubber and two spiral rollers were used for peeling of cobs. The peeling capacities at 24%, 28%, 30%, 32% and 34% moisture content of maize cobs were 878 kg/h, 837 kg/h, 935 kg/h and 1000 kg/h, respectively. The peeling capacities of the manual and power peelings were 60 kg/h and 837 kg/h respectively at 28% moisture content. The average engine and machine speed were 1225 and 325 rpm, respectively. During operation, rubber rollers were stopped to move which reduced the capacity of the machine. This problem will be eliminated by reducing and adjusting gaps between the spiral and rubber rollers. This experiment will be continued in the next year for its better performance.

Design and development of a low cost power driven tomato and potato grader

Grading of tomato and potato are a direct benefit to all parties concerned in the buying and selling transaction. Manually grading of tomato and potato are laborious job and costly operation. A rotating cylinder type tomato and potato grader was developed in Farm Machinery and Postharvest Process (FMP) Engineering Division of Bangladesh Agricultural Research Institute (BARI) in 2015-2016. The overall dimension of the grader is 3070mm×690mm×1150mm. The grader was made of locally available MS angle bar, MS flat bar, MS rod, MS sheet, MS shaft, ball-bearing, V-belt, V-pulley, and other small items. A 4 hp diesel engine was used to rotate cylinder at 15 rpm. Four grades of potatoes were obtained from the grader through four outlets of three cylinders. These sizes were small (<28mm dia.), medium (≥28 to ≤40mm dia.), medium large (≥40 to ≤55mm dia.) and large ≥55mm. The average capacity of grader for tomato and potato were 1.34 t/h, 1.52t/h and damage rate were found 20%, 2%, respectively. The experiment will continue to the next year for its better performance.

Development of a mechanical vegetable washing machine

Proper postharvest processing and handling are important parts of modern agricultural production. Postharvest processes include the integrated functions of harvesting, cleaning, grading, cooling, packaging, storing, transporting and marketing. The adoption of improved postharvest practices can reduce a substantial amount of food losses, improve overall food quality and safety, enhance consumers' acceptance, and thus add to the value of the marketable products. Based on the base line information, a mechanical vegetable washing machine was designed and fabricated with locally available materials at Farm Machinery & Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur in 2015-2016 to clean the vegetables with less cost and quickly. Overall dimension of the machine is 3759 mm × 1473 mm× 1676 mm. It was made of two units on the basis of vegetables types. One was for leafy and fruit vegetables and another one was for root vegetables. Main parts of the leafy and fruit vegetables unit were such as trapezoidal type water tank; mesh type conveyer; power transmission system; water supply system; and trays. Main parts of the root vegetables unit are such as chassis; brush type roller; power transmission system and water supply system. Both the conveyer net and brush roller were operated by an electric motor of 1.1 kW. The water was flown through the pipe by centrifugal water pump of 1.1 kW. Washing time for fruit, leafy vegetables were 32 second and ranged from 2 to 3 minutes for root crops depending on the amount of dirt of surface of the vegetables. Water requirement for washing vegetables was 3-5 t/h. The capacities of the machine were ranged from 1 to 2 t/h for leafy, fruit vegetables and 0.5 t/h for root vegetables. The cleaning efficiency was about 98%. Considering unique machine for all kinds of vegetable, washing cost was 0.16 Tk/kg. For considering individual unit of the machine for leafy and fruit vegetable unit, washing cost was found to be 0.13 Tk./kg and 0.41 Tk./kg for root vegetables unit. Payback periods and breakeven points were 21 days and 93 h/yr, respectively. Benefit cost ratio (BCR) of the machine was 3.7. Weight of the vegetable washing machine is 646 kg. The price of the machine is about 250,000Taka (US$ 3205). Farmers and traders would be benefited using the washing machine in custom hire basis at the rate of Tk 0.75-1.00 per kilogram of vegetable.

Improvement and performance evaluation of a mini oil expeller

A mini oil expeller was designed and fabricated at the workshop of the Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the period of 2013-2015. Overall dimension of the expeller 840×797×815 mm and power required to operate the machine was 4.5 hp. The smaller mini expeller can be fitted on a rickshaw van so that the service providers of rural areas can use it as custom hire basis. Two kilograms of mustard was expelled per batch. The average engine and machine speeds were 1475.5 and 14.89 rpm, respectively. Average oil recovery was 36.25% that was higher than the oil recovery from previous oil expeller (33.5%). Oil extartion from mustard, groundnut, sunflower, niger and saflower were 33.0, 30.0, 32.0, 34.0 and 32.5%, respectively. The oil extration capacity of the mini oil mill for extration of oil from mustard, groundnut, sunflower, niger and saflower were found to be 6.25, 4.80, 6.67, 6.00 and 4.00 kg/h, respectively. There were some problems observed during operation. The machine became sometimes stuck during operation. This experiment will be continued in the next year for improvement.

Modification of a hot water treatment plant for fruits

Existing small BARI hot water treatment plant for fruits was operated mainly by electric power of 12 to 15 KW. Conveyer rollers and stirrer were rotated by a single phase electric motor and water was warmed by single phase electric immersion heaters. In rural areas, 12-15KW single phase electric lines was not available though any place available but also load shading is occurred. Traders/farmers want to connect said power electric line for any plant; authority of REB does not agree to install another new transformer. If authority agrees to install the line, trader and farmers need lot of money that is not effort for all farmers and traders. For this reason, a simple and less electricity requirement hot water treatment plant was designed and fabrication with stainless steel (SS) materials in the Farm Machinery & Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2015. The overall dimension of the plant is 1600×1100×1600 mm. An electric motor of 0.38 KW used for rotation of conveyor roller and stirrer, and six electric immersion heaters of 2 kW each used. Four heaters out of six are used for treating fruits and other two heatersare used as auxiliary heatersfor instantly recover the heat that absorbed by the immersion treated fruits. Four alternative heating sources were usedsuch as chula for fire wood, LP gas burner, kerosene chula and electric heaters for heating of waterupto desired level of temperature. The lowest heating cost and time was found in fire wood chula followed by LP gas chula, kerosene chula and electricity. It polluted the environment but electricity was the second lowest cost and friendly environment. The price of the plant is Tk. 1,20,000 ($1600).This plant can be used where electricity is not available and also be used as alternative energy to electricity for heating water.

Design and development of palm oil nut and fiber separator and expeller

Palm oil is low-cost edible oil. There are some palm orchards available in different locations of Bangladesh. Palm fruits are usually used to harvest palm oil. Farmers of Bangladesh are in deep trable with these palm fruits due to lack of suitable machine for palm oil extraction. Therefore, this research work is aimed at solving the associated problems and difficulties inherent in the separation of palm nuts from fiber and develop a mini oil expeller to harvest palm oil from palm fruits. There are two parts of the experiment, one is palm nut and fiber separator and other portion is to expel oil from fiber. A palm nut and fiber separator was designed, fabricated and tested. The basic features of the separator are feeding chute, peeling unit, separating unit, discharge outlets and the prime mover. The palm nut and fiber separator gave the best performance with sterilized dry palm fruit. The throughput capacity, separating efficiency and fiber receiving percentage were 201.4kg/h, 96.3% and 40% respectively. The power required for operating the machine was 2.428 KW. Oil expelling from fiber is designed and fabrication is going on.

Development of heat pump dryer for heat sensitive crops

A heat pump was designed and fabricated in Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2013-16. The heat pump consisted of rotary compressor (2.75 kW), coil type condenser, expansion valve (electronic control) and hydrophilic type evaporator. The average temperature difference between outlet and inlet of heat pump was 10.39 ºC. At heat pump outlet temperature of 40 ºC, the outlet relative humidity was 53% that was 10% less than the ambient relative humidity. The average relative humidity difference between outlet and inlet of heat pump was 13%. Jute leaves of local variety was dried in the heat pump dryer during the month of June 2015. Time required to dry 16.0 kg of fresh jute from initial moisture content of 81.17% (wb) to 4.42% (wb) 21 hours. Time requred for moisture removal from basil leaves from an initial moisture (83.77%, wb) to final moisture content of 9.55 %, wb) in the heat pump dryer was 18 hour. The sample was dried in the open sun. Within the same 18 hours, moisture content of open sun dried sample reduced from an initial moisture content of 83.15% (wb) to 53.10% (wb). Therefore, heat pump dryer is found technically suitable for drying heat sensitive plants.

Development of a cream separator

Cream is a processed milk product which has diversified use in food industry such as preparing ghee, ice cream, sauces, soups, stews, puddings, and custard etc. In order to separate cream, milk needs to stir up by any mechanical means. The farmers used a bamboo stick to seperate the cream from milk. The traditional method is not hygienic and needs intensive human labor and the capacity of this practice is very low. A study was taken to design and fabricate a cream separator machine. Design of the prototype machine has been prepared in Solid Works-2016. The machine will be fabricated in stainless steel, to ensure minimum food contamination. The fabrication, field trial and cost analysis will be done in the next year.

Development of a power coconut dehusker

Coconut produced about 0.37 million tons in Bangladesh. Husk of coconut is removed for getting nut and shell as raw materials in coconut oil industries and for edible purposes in household level.

Husking is done manually by sharp iron in oil industries and retail markets in our country. The work is hard and required high skill and strength. The study was undertaken to develop a power coconut husking machine for dehusking coconut easy and quickly. This study was conducted at Farm Machinery and Postharvest Process Engineering Division, Gazipur during 2015-2016. It was made of locally available MS (mild steel) materials. The overall dimension was 910×690×1130 mm. Functional parts of the machine were main frame, power transmission system, dehusking unit and electric motor. Dehusking unit consistedof two rotating spike roller made of galvanized iron (GI) pipe along with some spikes. An electrical motor of 2.24 KW was used as a prime mover. Motor rpm was stepped down from 1450 to145 by means of gear reducer (ratio: 1:10). Operating speeds of the drive and driven spike rollerswere40 rpm and 35 rpm respectively. Weight of the machine is 250 kg. The capacity of the machine ranged from 450 to 500 coconuts per hour. The husking efficiency was 98 percent. Capacity of the machine was about three timesmore of the traditional husking. The breakage of nuts was found to be one percentage. Operating cost of coconut was 200 Tk per 1000 nuts.. Price of the machine was Tk. 620000. The machine would be useful for commercial purpose in coconut oil industry, wholesale and retail market for shelling coconuts.

Technical back up to manufacturers for machinery prototype development and fine tuning of existing machines

Group meeting and orientation of technical staff of machinery manufacturers were conducted for improve understanding about seeding implements in FMPE Division, BARI Gazipur 2015-16. Flute type seed metering dye produced by the local manufacture successfully and inclined plate seed metering device dye also produced in Rajsahahi. Relationship between researchers and manufacturers improved which reflect in machinery production. Progressive farmers need to close contact with manufacturers for display machinery product and feedback collection. A Saifeng type bed planter has been developed under this programme in Rajshahi. Manufacturers are able to understand technical functioning components of the implements. Manufacturers showed interested in fabrication BARI mobile maize sheller and potato harvester.

Design and establishment of a ‘tillage-cum-seeding laboratory’ at the fmpe division for advanced farm machinery research

An above floor level indoor soil bin system was designed and constructed at the FMP Engineering Division of Bangladesh Agricultural Research institute, Gazipur. The soil bin would allow testing of agricultural machinery in controlled soil condition. The soil preparation technique provided a soil bed with uniform soil moisture and bulk density. However, the process of preparing a consistent soil condition repetitively needs to be explored.

The tool carriage allowed setting of the rotary blades for strip-tillage and change of cutting widths, depths and forward speeds. Currently there is no mechanism to test seed meters or seed placement systems. Therefore, a seeding system needs to be designed and integrated into the tool carriage. The facility need to be demonstrated among the scientists, academics and university students to develop interest and attract research projects.

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International Competitiveness of Selected Pulse Crops in Bangladesh

The study was undertaken to assess the financial and economic profitability of selected pulse crops in Bangladesh. One hundred eighty pulse growers were randomly selected in Rajshahi, Natore and Jessore districts for the study. Net return analysis was done on both variable and total cost basis. Policy Analysis Matrix (PAM) and Domestic Resource Cost (DRC) analysis were also done for estimating comparative advantage of the selected pulse crops. The study revealed that net returns were positive for all pulse crops. However, the highest net return was estimated for lentil (TK. 75,235/ha) followed by chickpea (TK. 42,119/ha). Comparatively lowest net returns was found for mungbean (TK. 34,435/ha). The highest benefit cost ratio (BCR) was also for lentil (2.07) followed by chickpea (1.64). PAM and DRC analysis showed that Bangladesh had comparative advantage for producing all selected pulse crops as the estimates of domestic resource cost (DRC) were less than one implied that the production of pulse crops would be highly efficient for import substitution.

Utilization of Char Land through Pumpkin Cultivation by Using Sandbar Cropping Method in Northern Region of Bangladesh

The study was carried out to find out the profitability and export potentialities of pumpkin cultivation in Rangpur and Gaibandha district of Bangladesh. A total of 120 pumpkin growers taking 60 farmers from each district were randomly selected for the study. Net return analysis was done on both variable and total cost basis. Domestic resource cost (DRC) analysis was also done for estimating comparative advantage of pumpkin production. The study revealed that net returns was positive for pumpkin cultivation. However, the highest net return was estimated for Rangpur district (Tk 105,299/ha) followed by Gaibandha district (Tk 93,936/ha). The higher benefit cost ratio (BCR) was also for Rangpur (2.46) followed by Gaibandha (2.40). Bangladesh had comparative advantage for producing pumpkin as the estimates of domestic resource cost (DRC) was less than one. The value of DRC for pumpkin was less than unity implied that the production of pumpkin would be highly efficient for export promotion.

Profitability of Betel Leaf Cultivation and its Constraints to Higher Production in Some Selected Areas of Bangladesh

The study was conducted in three betel leaf growing areas namely Noakhali, Rajbari and Khulna district during 2015-16 to assess the agronomic practices, profitability and to explore the constraints to betel leaf cultivation. The findings of the study revealed that betel leaf cultivation was profitable in the study areas, although BCR in the first and second year were below one due to high investment cost and low yield. Highest yield and gross return were received by the farmers in the fourth year. The benefit cost ratio was found highest in fourth year followed by third year and fifth year. The benefit cost ratio at 12%, 15% and 20% rate of interest were 1.16, 1.15 and 1.14 respectively. IRR was calculated 59% in current situation, IRR 42% was found by 5% decrease of return and IRR 52% by 5% increase of cost. The result indicates that betel leaf cultivation is profitable under changing situation of sensitivity analysis. Farmers faced some constraints like leaf rot disease, high price of boroj materials, non-availability of modern variety, low price of betel leaf, high price of oilcake, vine died, lack of capital, etc. Breeders should take initiative for developed high yielding varieties of betel leaf.

Socioeconomic Impacts of Introducing Lentil and Mungbean into Rice-Based Cropping Systems in Western Bangladesh

The study was conducted in eight districts to evaluate the performance of improved technologies at farm level for providing feedback and output of the project. The study analyzed data that were randomly collected from 480 lentil (*Masur*) and mungbean farmers spread over eight project districts. Half of the farmers were selected who cultivated lentil and mungbean under demonstration plot and the rest farmers were treated as control. Due to the efforts of ACIAR project, 64-83% farmers adopted BARI Masur-6 variety and 64-70% adopted BARI Mung-6 due to their high yielding performance and disease resistant nature. Demo farmers collected improved seed from project source, whereas non-demo farmers mostly purchased seed from market and neighbors. Most demo (52-79%) and non-demo (41-74%) farmers had sown lentil and mungbean seeds at optimum sowing time. Line sowing was followed by 53% demo and 25% non-demo mungbean farmers, which was 25% in the baseline survey. About 51% demo lentil and 60% demo mungbean farmers treated their seed before sowing. All sampled farmers irrigated their crops once a season. Sixty four percent lentil demo and 45% mungbean demo farmers interested to increase pulses cultivation in the next year due to received various benefits. Fifty four percent non-demo lentil and mungbean farmers also wanted to expand pulse cultivation due to lower cultivation cost, higher profit, increase soil fertility, required less time and irrigation. Stress tolerant varieties, small seeded mungbean variety, quality fertilizers, pure pesticides, hand-on training on production practices, fair price of produces, institutional credit facilities, and mechanized harvester for picking mungbean pods with low cost and time were demanded by the sample farmers in the study areas.

Socioeconomic Determinants of Modern Potato Varieties Adoption and Resource use Efficiency in Northern Bangladesh

This study evaluated the determinants of choosing modern potato variety and its' productivity while allowing for production inefficiency at the level of individual producers. Results revealed that modern variety selection decisions are influenced positively by younger age and gross return from potato and negatively by a rise in the relative price of seed and wage of labour. Stochastic production frontier results revealed that land, labour and irrigation are the significant determinants of modern potato productivity. The mean level of technical efficiency (MTE) is estimated at 82% indicating that farmers can able to increase their yield about 3631Kg/ha which is equivalent to Tk 41250/ha. Policy implications include measures to increase land reform and keeping potato prices high to boost farm returns and offset the impact of a rise in the labour wage which will synergistically increase the adoption of modern potato as well as farm productivity.

Study of Mandarin Cultivation in Selected Areas of Bangladesh

The study was conducted in three districts namely Panchoguor, Bandarban and Moulovibazar to know the production technology of mandarin cultivation, to estimate profitability and identify the constraints of mandarin cultivation. A total of 99 farmers taking 33 from each district were selected randomly. Data were collected through a pre-tested schedule during January-March, 2016. Cost return analysis revealed that mandarin cultivation was profitable in the study areas. The highest cost was estimated Tk. 215293/ha in 16-20th year garden and lowest cost Tk 119993/ha in 2-4th year garden. Highest yield was found 16020 kg/ha at 11-15th year garden followed by 13800 kg/ha at 16-20th year garden and lowest yield 11100 kg/ha at 5-10thyear garden. The highest gross return was found in Tk. 640800/ha at 11-15th year garden and lowest return was Tk. 444000 at 5-10th year garden. The highest amount of net return was found Tk. 435859/ha at 11-15th year garden and lowest return was Tk. 235286 in 5-10th year garden. The benefit cost ratio at 12% rate of interest was 1.68, NPV Tk. 920401 and IRR 30%. Sensitivity analysis implied that mandarin cultivation is profitable. Scarcity of irrigation in hill areas, acute problem of insect/ pest infestation, lack of improved production technology, poor quality and scarcity of seedlings/ saplings, lack of capital for initial investment and low yield of different varieties were found major constraints for mandarin cultivation in the study areas.

Consequences of Drought in Maize Production in Selected Areas of Bangladesh

The study was conducted in four districts namely, Rajshahi, Jheniadah, Comilla and Rangpur during 2015-2016 to estimate the effect of drought in maize production, technical efficiency and adaptation strategy of maize farmers, and explore related problems of maize cultivation in the study areas. Rajshahi and Jhenaidah were selected as drought prone areas whereas Rangpur and Comilla were selected as favorable environment. A total of 200 farmers taking 50 from each district were selected randomly for the study. Per hectare total cost of maize cultivation in drought prone areas was found TK. 92,582, whereas in normal environment it was TK. 79,594. Per hectare average yield in drought prone and normal areas were 7576 kg and 8729 kg, respectively. Per hectare net return of maize in drought prone and normal areas were Tk. 28,062 and TK. 59, 871, respectively. On full cost basis benefit cost ratio (BCR) in drought prone and normal areas were 1.31 and 1.75, respectively. Result of semi-logarithmic regression model indicated that maize production was decreased by 22.4 percent in drought prone areas than normal environment. Loss of yield (70%), loss of plant growth (55%) and problem in flowering stage (43%) were reported to be the major effects of drought. The major adaptation strategies in the drought prone areas were increase number of irrigation (77%), increase amount of fertilizer (42%) and seed (31%) and change of planting date (30%). The coefficient of human labour, seed, chemical fertilizer and insecticides were positively significant in normal environment. However, human labour, irrigation cost and land preparation cost were found positive and significant in drought prone areas. In maize cultivation, the coefficient of experience, education of the farmers and training dummy had positive and significant impact on technical efficiency. Higher price of irrigation (70%), lack of drought tolerant variety (48%) and lack of quality seed (31%) were the major problem in drought prone areas. Again, disease infestation (64%), lack of quality seed (41%) and high price of seed (36%) were the major problem in normal environment.

Adoption and Profitability of BARI Wheat Varieties in Jamalpur and Sherpur District

The study assessed the level of adoption and profitability of wheat varieties at farm level. Data were collected from 90 randomly selected wheat farmers from Jamalpur and Sherpur districts. The results indicated that BARI Gom 24(Prodip) was highly adopted variety (28%) followed by BARI Gom 26 (21%), BARI Gom 21(Shatabdi) (16%), BARI Gom 25 (13%), BARI Gom 23 (Bijoy) (8%). The adoption levels of ploughing and fertilizer use were low whereas planting time and irrigation were high. Per hectare average total cost producing Prodip was highest (Tk 54211) followed by BARI Gom 25 (Tk 54192), BARI Gom 26 (Tk 51782), Bijoy (Tk 50425) and Shatabdi (Tk 49323) due to the higher cost of human labour, fertilizers and irrigation cost. The yield of Prodip was highest (3.89 t/ha) followed by BARI Gom 26 (3.67 t/ha), BARI Gom 25 (3.37 t/ha), Shatabdi (3.14 t/ha) and Bijoy (3.04 t/ha). Per hectare net return of Prodip was highest (Tk 15169) followed by BARI Gom 26 (Tk. 13858), Shatabdi (Tk 7307), BARI Gom 25 (Tk 6348) and Bijoy (Tk. 4505). Attacks of rat and bird, unavailability of new variety seed at proper time and lack of technical knowledge about improved cultivation practices were the major constraints for the adoption of wheat technologies.

Relative Profitability of Different Cropping Patterns in the Chittagong Region

The study was carried out in three selected villages namely Soabil, Khorna and Mohadebpur under the Upazila's of Fatikchari, Patiya and Sitakondu in Chittagong District, respectively during 2015-16 with mainly to identify the profitable cropping pattern in the region. The highest single cropped area was found at Fatickchari and lowest in the Sitakondu. This might be due to the availability of vegetable production in the Sitakondu area.The highest double cropped area was found in Fatikchari and triple cropped area in Patiya. This might be due to more irrigation facilities were availed in Patiya. It was reported that after the rice cultivation in all locations, the cauliflower (29%), tomato (26%), potato (56%), chilli (40%), bean (70%), brinjal (30%), yard long bean(6%), cucumber (Khira) (67%) and lady's finger (38%) were found as the major vegetables crops in all locations. About 73.3% farmers cultivated country bean in the selected area of Sitakondu. More than 80% farmers cultivated potato in Patiya. The highest 36.6% farmers cultivated chilli in Fatikchari. In the case of cropping pattern, the highest percentages of the farmers were operated the pattern of i.e. winter vegetables-summer vegetables-T. aman irrespective of all areas followed by winter vegetable-fallow-T.aman and Boro-Fallow-T.aman. It is mentioned that the winter vegetables were identified as potato, tomato, cauliflower, chilli, radish, brinjal, gourd etc. On the other hand, the summer vegetables were identified as cucumber (Khira), lady's finger, country bean, yard long bean, coriander etc. Among the cropping pattern the highest benefit cost ratio was found in winter vegetables-summer vegetables-T.aman followed by winter vegetables-fallow-T.aman irrespective of all locations. Among the locations, the highest profitability was recorded from winter vegetables-summer vegetables-T.aman in Patita followed by Sitakunda. Results revealed that the gross return was found as the highest from Boro rice at Tk.57646/ha irrespective of all locations. Age of respondents, education, family size, occupation, income from rice and vegetable cultivation with intercropping system, training and credit received was influenced on household income significantly. The highest 86.6% farmers reported that the highest irrigation cost was the main problem for crop production in all locations followed by low product price (74.4%) and low purity of seeds (61.1%). No farmer's innovation was found in the selected locations.The income from rice and vegetables cultivation (bean in Sitakondu, Sweetgourd&Khira in Fatickchai, Patato in Patiya) significantly contributed in their whole farm household income. If irrigation facilities could be provided, the four crop based cropping pattern such as (i) T.aman-Mustard/potato-Boro-T.aus (ii) T.aman-Mustard-Mungbean-T.aus can be suggested for improving the food security and household income in the region.

Production and Marketing Constraints of Black Gram in Char Land of Jamalpur and Sherpur Districts

The present study is an attempt to assess the present position, existing agronomic practices of black gram cultivation, its profitability and constraints of black gram production. It was conducted in purposively selected two black gram cultivated union in Sherpur and Jamalpur district on the basis of maximum area under this crop. The majority of the farmers had sown seeds during the last week of September to first week of October. The average seed rate was found to be 19.36 kg per hectare which indicated that all farm households used below recommended dose of seeds (35-40 kg/ha). About 23 and 33 percent of the total variable cost was for human labour in Sherpur and Jamalpur district, respectively. The average yield of black gram was found higher than the national average. The average gross margin was observed to be Tk. 41572/ha on total variable cost basis. The cost per kilogram of black gram cultivation was Tk. 35 and return from one kilogram of black gram production was Tk. 74. The results revealed that the main constraints faced by blackgram grower were lack of irrigation facility, low output price, labour scarcity, lack of proper knowledge about improved varieties, insect pest and diseases management, excessive rainfall after flowering and weak research-extension farmers linkage etc.. Farmers also faced some marketing related problems such as limited buyers, uncertain price, absence of cold storage and high market charge. Farmers cultivated black gram because of higher yield, higher income, and easy growing.

Assessment of Postharvest Losses and Food Quality by Evaluating Postharvest Practices and Marketing Performances in Selected Vegetables Supply Chain in Bangladesh

Different studies assessed quantitative postharvest losses of vegetables based on field surveys, but loss assessment through physical monitoring of vegetable lots is rare in Bangladesh. Therefore, the study was carried out at Jessore, Kishoregonj and Mymensingh districts to estimate quantitative and qualitative postharvest losses of vegetables at various stages of supply chain using conventional, improved and cool chain packaging and transportation, and the financial impact of improved packaging over conventional method during January-April, 2016. Nine lots of vegetables namely, brinjal, country bean, tomato and bitter gourd were monitored using conventional, improved and refrigerated transportation system, and recorded data on postharvest losses and related financial costs for estimating cost-benefit analysis. The study revealed that the postharvest losses of vegetables were much higher for conventional method of packaging compared to improved and cool chain method. In conventional method, the percent of postharvest losses of brinjal, country bean, tomato, and bittergourd at traders' level were 27.2%, 29.5%, 22% and 9.9%, respectively. The corresponding losses were 16.4%, 23.1%, 17.7% and 9.2% under improved method, respectively. In cool chain method, the total loss of brinjal was 13.6% which was much lower than other two methods, but the system is not cost effective to the traders. In monetary term, the losses in conventional method ranged from Tk. 924-Tk.1482 per ton for selected vegetables which were 48-312% higher than improved method. In improved method, Bepari and retailers received net margins ranged from Tk.1219-Tk.4632 and Tk.2345-Tk.8866 per ton which were 10.4-42.6% and 3.4-6.0% higher than conventional method respectively. In cool chain method, Bepari received negative net margin (Tk.-2067) in brinjal marketing. The stakeholders gave emphasis on packaging high value vegetables using plastic crates which effectively minimize losses during distant transportation.

A Baseline Survey on Winter Tomato Supply Chain in Selected Areas of Bangladesh

Tomato is a popular and nutritious vegetable in Bangladesh. Due to the lack of appropriate pre- and post-harvest measures and inefficient supply chain, a lot of tomatoes are spoiled every year. Adequate data and information regarding these issues are lacking in Bangladesh. Therefore, the study *assessed the knowledge, attitude and practices (KAP) of key actors in winter tomato supply chains regarding pre- and post-harvest handling, food safety, food quality, and post-harvest losses, and the status of tomato market opportunities in Bangladesh. Sixty farmers and 91 traders in the tomato supply chain were interviewed from Rajshahi, Bogra and Dhaka districts. The results revealed that most farmers (100%) and traders (97-100%) showed positive attitudes towards crop maturity, safe tomato, importance of good packaging, consumers' awareness, and took various pre- and postharvest measures for keeping tomatoes safe for the consumers. The estimated average postharvest losses were 4.57% and 11% at farm and traders' level respectively. At farm level,* these losses occurred during sorting & grading (1.24%), transportation (0.95%), harvesting (0.94%), storage (1.03%) and other causes (0.41%). *T*he highest loss was recorded for retailer (4.71%) and the lowest for *Faria* (1.82%). This study identified seven supply chains for tomato marketing. The longest and prominent channel was *Farmer>Bepari>Urban Arathdar>Urban Retailer>Urban Consumer.* Farmers and *Farias* used different local carriers like bicycle, rickshaw, van, and push cart to transport tomato. Trucks and pick up van were mostly used by *Bepari* to transport tomato from assemble markets to distant wholesale markets. Retailer received the highest net profit (Tk.7,858/ton) due to higher sale price and lower marketing cost followed by *Faria* (Tk.2,444/ton) and *Bepari* (Tk.1,852/ton). Major marketing problems in the supply chain were delayed sale (64.3%), spoilage (61.4%) and lack of buyers (52.9%). Both farmers and traders suggested various measures to reduce postharvest losses and keep tomatoes safe for the consumers.

A Baseline Survey on Mango Supply Chain in Selected Areas of Bangladesh

A lot of mangoes are spoiled every year due to the lack of proper pre- and postharvest measures and inefficient supply chain. Sufficient data and information on these issues are lacking in Bangladesh. Therefore, the study *assessed the knowledge, attitude and practices (KAP) of key actors in mango supply chains and the status of market opportunities in Bangladesh. A total of 98 respondents taking 30 growers, 53 traders and 15 consumers were interviewed from Chapai Nawabganj and Dhaka districts. The results revealed that all growers (100%) and traders (97-100%) showed positive attitudes towards crop maturity, safe mango, and role of good packaging, and took various pre- and postharvest measures for keeping mangoes safe for the consumers. The estimated average postharvest losses were 14.11% and 9.61% at farm and traders' level, respectively. At farm level, these losses occurred during harvesting, sorting & grading, and transportation. Harvesting losses were due to cracking, bruising, compression, and disease and insect damage. T*he highest loss was recorded at retail level (4.64%) followed by *Bepari* (3.95%). This study identified eight supply chains for mango marketing. The longest and prominent channel was *Farmer>Bepari>Urban Arathdar>Urban Retailer>Urban Consumer.* Farmers and *Farias* used different local carriers, whereas trucks and pick up van were used by *Bepari* to transport mango from assemble markets to urban wholesale markets. *Faria* received the highest net margin (Tk.8,068/ton) due to lower marketing cost and spoilage followed by retailer (Tk. 6,601/ton) and *Bepari* (Tk.5,394/ton). Major marketing problems in the supply chain are delayed sale and lack of buyers. Both farmers and traders suggested various measures to reduce postharvest losses and keep mangoes safe for the consumers.

Accessibility to Supper Market Value Chain and Price Variability of Smallholder Vegetable Farmers in Bangladesh

The supply of agricultural products by farmers to super market is a new form of organized modern marketing based on consumer demand. The study was undertaken in three districts namely Narsingdi, Jessore and Dhaka to assess the three different chains in which two were under traditional supply chain and one was under super market value chain for a comparison of different aspect of vegetable marketing like marketing cost, margin, producer's share, Price variability and determinants of farmer's access to super market. Three vegetables namely brinjal, country bean, and tomato were selected for the study. A total of 145 sample consisting 90 farmers 40 traders and 15 consumers were interviewed for the present study. The study was conducted during the period in 2015-16. Data were collected from both primary and secondary sources. The per quintal total marketing cost was found highest for traditional supply chain-II which was Tk.804 for brinjal, Tk.800 for country bean and Tk.779 for tomato whereas it found lowest for super market value chain-III which was Tk.484 for brinjal, Tk.472 for country bean and Tk.520 for tomato incurred by different stakeholders of the respective chain. The per quintal total net value addition was also found highest for traditional supply chain-II and lowest for super market value chain-III .The producer share in consumer price of super market value chain (54%-60%) was higher than the traditional supply chains (42%-58%). Logit regression model revealed that education, motivation of any institution, receiving training and existing sale contact have significant and positive influence on producer decision for accessing any supper market. Multiple linear regression models reveled that yield, substitute, transport facility, seasonality, marketing cost and marketing margin have significant and negative relationship with brinjal price which indicated that these factors negatively influences the brinjal price and similar trend was also found in case of country bean and tomato. Friendly environment (100%), safe food (95%), good quality (90%), one stop shopping (100%), lower price (40%) & time savings (80%) were the consumer perception about super marketing. The rejection of lower grade vegetables and procurement of vegetables according to their indent were the major problems of super marketing.

Marketing System of Summer Tomato in Jessore District

The study was conducted for the assessment of marketing system of summer tomato in Jessore. Data were collected from 30 randomly selected tomato farmers and 60 traders from Jessore and Dhaka market. Farmer, faria, bepari, wholesaler, commission agents and retailer were involved in marketing of summer tomato. Marketing cost of farmar, faria, Bepari, wholesaler, retailer (urban) and retailer (rural) were Tk.43/quintal, Tk.69.10/quintal, Tk.218.35/quintal,Tk.244.27/quintal, Tk.185.67/quintal and Tk.107.35/quintal respectively. Net margin or profit of the faria, bepari, wholesaler and retailer were Tk.130.00/quintal, Tk.81.65/quintal,Tk.55.73/quintal and Tk.214.33/quintal, respectively. There were seven marketing channels identified in tomato marketing.

Assessment of Existing Value Chain of Date Palm in Bangladesh

The study was conducted for the assessment of existing value chain of date palm in Jessore. Data were collected from 30 randomly selected date palm farmers and 60 traders from Jessore, Magura and Jhenaidah. Analysis was done on per quintal (100 litre) raw juice basis. Farmer, processor, bepari and retailer were involved in processing and marketing of date palm juice. Total processing cost of date palm molasses was TK. 418.84 and for Patali gur it was TK. 422.31 per 100 litre juice. Marketing cost of farmar cum processor, Bepari and Retailer were Tk.29.00/quintal, Tk.26.25/quintal and TK.21.34 /quintal respectively. From 100 litre of juice it can get 16.67 kg of gur and for patali it was 15 kg. A farmer sell raw juice, molasses gur, patali gur and by product were TK.20/litre, TK.140/kg, TK.160/kg and TK.30 respectively by the farmers. Net margin or profit of the processor, bepari and retailer was TK.1552.16 /quintal, TK.138.75/quintal and TK.148.66 /quintal of juice respectively. There were six value chain exist in the date palm marketing. Processor, bepari and retailer added the value TK. 1552.16, TK. 138.75 and TK. 148.66 respectively to the value chain. Price gap between the consumers and producer was TK. 335 per 100 litre of juice. As producers and consumer price had less gap thus the producers share was 85.65 percent.

Study on Production and Price Relationship for Chilli in Bangladesh

The study estimated the fluctuation of area, production, yield and price of chilli and determined production-price relationship of chilli in Bangladesh using secondary data (1985-2014) from Bangladesh Bureau of Statistics. Data were analyzed using simplest method for fluctuation, and the Koyck model of distributed lag models. The results revealed that the extent of annual price fluctuation of chilli was between -55 to 111 percent, while the extent of fluctuation of area, production and yield ranged between -39 to 156, -27 to 161 and -17 to 55 percent respectively during the study period. Production swing, climatic condition and lack of storage facilities were the main causes of unstable price of chilli in Bangladesh. For preventing price fluctuation, government price control, improvement of farming and other infrastructures, provision of loan and subsidies, improvement of IT service, improvement of production technology and proper storage system are urgently needed. Again, chilli production in Bangladesh has been influenced by the lag value of average price formed in the market. The most striking result of the study is that the time required for the changes in the chilli prices to have an effect on chilli production is 6.09 years. The value of coefficient indicated that the changes in lag values of the prices had a positive influence on production, this influence was getting smaller. To reduce the risk and uncertainty of the chilli price, sustainable chilli farming and establishment of an efficient marketing organization is a necessity.

Climate Variability Stresses, Adaptation and Capacity Assessment of Farmers in Some Selected Coastal areas of Bangladesh

Climate change and its variability cause different biotic and abiotic stresses that negatively affect on agricultural crops and the livelihoods of coastal farmers. But data and information regarding these issues are scarce in Bangladesh. Therefore, the study was conducted to assess the adaptation knowledge and strategies to cope with climate variability, identify the factors that determine the adaptation capacity of the farmers, and identify potentiality and problem of adaptation to climate variability faced by the farmers. The study revealed that draught and uneven rain (100%) were the severe stresses followed by water salinity (30%), soil salinity (25%), disease infestation (21%) and insect attack (21). The differences of crop yields between adverse climatic condition and national average ranged from 3-78 percent, between normal condition and national average ranged from 1-65 percent, and between adverse climatic condition and normal climatic condition ranged from 40-78 percent. To adapt adverse situation farmers adopt different measures like reserve rain water, digging well, use salt tolerant variety, irrigation, drainage system, use pesticides, use insecticides, and migrate to other occupations on a temporary basis.

Occupational Shifting and Migration from Agriculture to Non Agriculture Sector in Some Selected Coastal areas of Bangladesh

The study was conducted in three southern districts namely Pirojpur, Jhalokathi and Barisal for the identification of the determinants of agricultural labour migration, social, economic and agricultural impact of labour migration etc. The study revealed that loss in agricultural activities (92%) were the major causes of labour migration followed by low price of agricultural commodity (86%), low labour wage (68%), high production cost (54%). Maximum farmers migrated outside of own area (55%). Some farmers migrated within own area (32%) and foreign country (13%). Migrants mainly involved in different activities but maximum migrants involved in full time non-agricultural activities outside own area (55 %). Some changes in agricultural pattern were found due to migration, besides migration increased the employment opportunity and hence social status. Age, family members and family income were the major determinants of agricultural labour migration.

Assessment of Training Needs for the Farmers of Bangladesh

Bangladesh Agricultural Research Institute (BARI) conduct a variety of trainings for the benefit of farmers of different crop intensive areas of Bangladesh. Identification of training needs is the most important step in any organizations training programme. The present study on training needs assessment of the farmers was conducted by Training and Communication Wing of BARI. A list of nine (9) major components/ thematic areas was prepared. Under each major component, specific and relevant training needs item were collected and systematically incorporated into an interview schedule and administered in terms of frequency of training imparted. The results revealed that even in the most crop intensive areas, there was an inadequacy of necessary training. Farmers sought maximum trainings on seed production, integrated pest and disease management, bio-control of pests and diseases, soil and water conservation, management of problematic soils and post-harvest technology of vegetables and fruits. Respondents defined identification of adulterated fertilizer, insecticide and pesticide application, disease and insects of mango varieties and fruit bagging system of mango as very good type of training. Lack of markets/information about markets, low prices, high cost of inputs (e.g. fertilizer, seeds), poor or insufficient training, pests and diseases problem scored the highest among the problems that respondents face in their crop production activities. The BARI have to re-orient their trainings based on these findings to reduce the existing technological and adoption gap among the farmers.

13 PLANT GENETIC RESOURCES

Exploration and Collection of Plant Genetic Resources for Food and Agriculture

Exploration and collection program was carried out on different BARI mandate crop germplasm in 52 upazilas of 20 districts in Bangladesh during 2015-16. The collection team were well equipped with vehicle, GPS, camera, hand lens, seed envelops, polybags, scissors, knife, etc. One thousand one hundred and forty one germplasm of 87 BARI mandate crops (Cereals-25 germplasm of 7 crops; pulses- 44 of 9 crops; oilseeds- 95 of 5 crops; vegetables- 819 of 41 crops; spices-109 of 10 crops; fruits- 34 of 10 crops and 15 germplasm 5 other crops) were collected from 52 upazilas/thanas of Manikganj, Tangail, Mymensingh, Sherpur, Jamalpur, Narayanganj, Gazipur, Kishoreganj, Jhenidah, Jessore, Narsingdi, Dhaka, Chittagong, Comilla, Rangpur, Thakurgaon, Chapainawabganj, Nilphamari, Panchagarh and Dinajpur districts. The germplasm were collected from farmers' field, threshing floor, garden, farm store, market etc. The status of the sample was mostly landraces. The samples were collected as seeds, seedlings, fruits, bulb and rhizome from individual plant or population. Passport information like name of donor with village, union, upazila, district, latitude and longitude were recorded during collection. A 'Passport Data Form' having passport information was filled up during germplasm collection. The samples were registered in conservation book immediately after collection and conserved in long term conservation unit following appropriate procedure.

Exploration and Collection of Chilli, Cucumber and Melon Germplasm

A target oriented exploration and collection program was carried out on chilli (*Capsicum frutescens*), cucumber (*Cucumis sativus*) and melon (*Cucumis melo*) germplasm in 44 upazilas of 19 districts in Bangladesh under AFACI-IMPGR project during 2015-16. Four hundred twenty five germplasm of three target crops (chilli-186, cucumber-146 and melon-93) were collected from 44 upazilas/thanas of Manikganjj, Tangail, Mymensingh, Sherpur, Jamalpur, Narayanganj, Gazipur, Kishoreganj, Jhenidah, Jessore, Narsingdi, Dhaka, Chittagong, Comilla, Rangpur, Thakurgaon, Bogra, Chapai Nawabganj and Natore districts. The germplasm were collected from farmers' field, threshing floor, garden, farm store, market etc. The status of the sample was mostly landraces. The samples were collected as seeds, seedlings and fruits from individual plant or population. Passport information like name of donor with village, union, upazila, district, latitude and longitude were recorded during collection. A 'Passport Data Form' having passport information was filled up during germplasm collection. The samples were registered in conservation book immediately after collection and conserved in medium term conservation unit following appropriate procedure.

Characterization of Hyacinth bean Germplasm

An experiment was conducted with 50 germplasm of hyacinth bean (*Lablab purpureus* L. Sweet) to estimate the characterization and variability. Green and purple colours were found in hypocotyl, epicotyl and leaf vein among the germplasm. Absence of pigmentation, almost solid purple, extensive purple and purple localized to nodes were found on main stem. Absence of leaf anthocyanin was observed among the germplasm. Pale to dark green leaf colour intensity were found. Variations were observed in ramification index, raceme position and orientation of pod bearing raceme. The germplasm were exhibited white (30%) and purple (70%) flower. Green (60%), green with purple margin (26%), yellow-green with purple margin (2%), purple (8%) and white (4%) edible pod colours were found. Flat (56%), elongate (42%) and elongate wavy (2%) edible pod shape along with straight (68%) and slightly curved (32%) pod curvatures were observed. Variation of seed colour such as black (62%), brown (20%), yellow-white (6%), grayed-orange (6%) and bicolour-brown with cream (6%) were found. Small (28%), medium (36%) and large (36%) seed size along with ovoid (68%), flat (28%) and elongate (4%) seed shape were exhibited. Days to first flowering were ranged from 48 to 92 days and edible pod stage were ranged from 63 to 126 days. Variations were observed in leaf length and width, length of rachis and peduncle, number of flowering nodes per rachis and number of pods per rachis. A good range of variations was also observed in edible pod length (6.67 to 15.00 cm), width (1.78 to 4.50 cm) and pod weight (6.16 to 24.20 g). The germplasm were produced 63 to 710 pods per plant and 3 to 6 seeds per pod. The highest CV was observed in number of pods per plant (49.38%) and the lowest was observed in leaf length (6.64%). Some promising germplasm were identified.

Characterization of Chilli Germplasm

The experiment was conducted with 66 germplasm of chilli in the experimental field of Plant Genetic Resources Centre (PGRC) of BARI, Joydebpur, Gazipur, during winter 2015-16 to find out the variability in the germplasm. The germplasm of chilli was collected from different regions of Bangladesh. Qualitative characters showed distinct variation among the germplasm except calyx margin shape and fruit persistence. The maximum variation was observed in stem colour, branching habit, leaf colour, leaf shape, leaf pubescence density, corolla colour, pedicel position, fruit shape and fruit colour at immature and mature stage. Four categories stem colour such as green with few purple strips (65.15%), green with many purple strips (6.06%), purple (3.03%) and their mixture (25.76%) were observed before transplanting. After transplanting it was found three categories such as green (25.76%), green with purple stripes (71.21%) and purple (3.03%). Leaf shape exhibited as ovate and lanceolate. Leaf exhibited as green (62.12%), dark green (34.85%) and others (mixture of green and purple (3.03%). The maximum germplasm exhibited as bushy plant. Pedicel position at anthesis found as pendant (19.70%), intermediate (56.06%) and erect (24.24%). Fruit colour (mature and immature stage) observed in three types viz. green, purple, green with blackish blush. Green colour observed in maximum germplasm at both stages. Purple coloured fruit found in germplasm AHM-198, AHM-199. The highest coefficient of variation was observed in yield per plant (99.22%) followed by number of fruits per plant (76.31%) and flowering to fruiting period (60.90%). The germplasm RT-29 (104.71 g/plant) AHM-227 (91.23 g), RT-28 (54.94 g), AHM-259 (52.36 g) and RT-34 (51.38 g) were found better yielder among germplasm.

Characterization of Grass pea Germplasm at Ishurdi

The study was conducted at Regional Plant Genetic Resources Centre, Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2015-16 to identify the important traits of grass pea accession. The experiment involved 57 grass pea accessions. Variations among grass pea accessions were observed in different qualitative characteristics like stems, leaves and flowers. Variations in plant growth habit like prostrate, spreading, semi-erect and erect were observed. Different flower colour viz. white for 1 accession (1.75%), white blue for 23 accessions (40.35%), blue for 10 accessions (17.54%), pink for 1 accession (1.75%), violet blue for 21 accessions (36.84%) and violet for for 1 accession (1.75%). Different seed shape viz. rhomboid for 54 accessions (94.74%), square for 2 accessions (3.51%) and obtriangular for 1 accession (1.75%) were observed among the accession. Variations were observed in respect of days to first flowering, days to 50% flowering, days to maturity, plant height, number of seeds per pod, 100-seed weight and yield per plant among the accessions. The first flower initiation was earlier in BD-4908 (53 days) and days to 50% flowering was earlier in BD-5065 (69 days). The earlier maturity was observed in BD-4907 (108 days). BD-4789 produced the highest number of seeds per plant. The highest seed yield (29.64 g/ per plant) was recorded from BD-5127 accession and the lowest yield (6.48 g/ per plant) from BD-4738 grass pea accession.

Characterization of Grass pea at Jamalpur

Forty seven (47) accessions of grass pea (*Lathyrus sativus L.*) were characterized at Plant Genetic Resources Centre (PGRC), RARS, Jamalpur. Variation was presented in all characters except stem colour, leaf type, and flower colour. Plant growth rate stage-I showed medium-17 and high-30, prostrate-04, spreading-16, semi-erect-26 and Erect-1 accession. For leaflet shape linear-34, lanceolate-9 and ovate-lanceolate-4; green-25 and dark green-22 for leaf colour, globular-35 and intermediated-12 for flower bud shape, small-6 and medium-41 for flowers size were observed. The pod shape such as oblong-elliptical-5, medium oblong-elliptical-32, breaded-7 and broad linear-3 other character pod curvature straight-40, slightly carved-5 and carved-2. On an average, the plant height was 55.15 cm, number of pods per plant was 28.76, pod length 2.67 cm, pod width 1.76 cm and number of seeds per pod 3.80. The range was obtained for number of primary branch 5 to18, length of primary branch 21.5 to 74.5 cm, days to first flowering 57 to 75 days, number of pods per plant 14 to 55 and 100-seed weight 3.1to 11.1g, respectively. The maximum CV found for number of primary branch 29.44% followed by 100-seed weight 25.08% and length of primary branch 23.57%.

Characterization of Grass pea Germplasm at Jessore

Performance of 69 grass pea (*Lathyrus sativus*) genotypes was studied at the Regional Agricultural Research Station, Jessore during the *rabi* season of 2015-16. Morphological variations were observed among the accessions for 11 qualitative characters viz. seedling vigor, plant growth habit, stem color, leaf color, leaf size, leaflet shape, leaf tendrils, flower size, flower color, pod shape and seed size.

Characterization of Chickpea Germplasm

The experiment was conducted with 71 accessions of chickpea (*Cicer arietinum* L.) for estimating the genetic diversity. The maximum variations were observed on flower colour and seed colour. There were five types of flower colour such as blue 1.41%, light blue 7.04%, pink 32.39%, light pink 53.52% and white 5.63% accessions. The seed colour were observed five such as brown 18.31%, light brown 4.23%, dark brown 64.79%, greyish brown 9.86% and grey 2.82%. Plant pigmentation showed no anthocyanin 15.49%, low anthocyanin 83.10% and high anthocyanin 1.41%. Semi-erect 5.63%, semi-spreading 39.44% and spreading 54.93% growth habit were observed. All accessions showed multipinnate leaf type, small leaflet size, short pod size and angular seed shape. The number of leaflet per leaf ranged from 2.32 to 20.38; number of basal primary branch, 2.33 to 8.33; days to 50% flowering, 77 to 92 days; number of pods per plant, 6.33 to 58.33; pod length, 3 to 6.33 mm; number of seed per pod, 1 to 2.20 and 100 seed weight, 8.40 to 19.50 g. The maximum coefficient of variation was obtained from the number of pods per plant 49.60% followed by number of leaflet per leaf 41.83%, number of basal primary branches (25.56%). The minimum coefficient of variation was recorded for days to 50% flowering 4.51%. Percent of coefficient of variation indicated the variability among the accessions comparing within the characters.

Characterization of Pumpkin Germplasm

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during 2015-16 to know the diversity of 27 accessions of pumpkin (*Cucurbita moschata*). Qualitative character variation was found in early plant vigour, plant growth habit, leaf size, leaf pubescence nature and leaf pubescence density. Globular (74.08%), flattened (7.41%), cylindrical (3.70%), elliptical (3.70%) and elongate form (11.11%) fruit shape having matt (18.52%), intermediate (44.44%) and glossy (37.04%) fruit skin lustre were observed. Different color variations were exhibited in mature fruit skin color (yellowish-70.37% and orange-29.63%), fruit skin color pattern (uniform-25.93%, mottled-62.96% and striped-11.11%), fruit skin color intensity (intermediate 62.96% and dark-37.04%) and mature flesh color (yellow-44.44% and deep yellow-55.56%). Matt and glossy seed lustre observed among the accessions. The highest CV was found in fruit length (30%) and the lowest in days to female flowering (2.36%).

Characterization of Amaranth Germplasm

Fifty accessions of amaranth (*Amaranthus* spp) were studied at the Plant Genetic Resources Centre of BARI, Gazipur during 2015-16 to get the knowledge about diversity of that crop. All the accessions exposed variation both for qualitative and quantitative characters. Qualitative variation was found in different parameters as branching index, stem and leaf pubescence, leaf shape, leaf margin, terminal inflorescence attitude, inflorescence density index and so on. Different color variations were exhibited in stem (green 10% and pink or purple 90%), leaf (entire lamina purple or pink 24%, basal area pigmented 8%, margin and vein pigmented 12%, normal green 8% , dark green 8% and other 40%), petiole (green 10%, purple 75% and dark purple 15%), inflorescence (green 12.5%, yellow 2.5%, pink

15%, red 2.5% and other 67.5%) and seed (pale yellow 2.5%, red 7.5% and black 90%). In case of quantitative character, mean plant height was 47.37cm.The plants of different accessions flashed with flower within 34-131 days giving 13.62 cm long inflorescence on an average. The highest CV was found in case of 1000 seed weight (48.33%) and the lowest in length of axillary inflorescence (17.04%).

Characterization of Cucumber Germplasm

Twenty one accessions of cucumber (*Cucumis sativus* L.) were characterized at Plant Genetic Resources Centre (PGRC), BARI, Gazipur during suumer, 2015. Variability showed in different fruit characters at edible stage i.e stem end fruit shape and blossom end fruit shape. Fruit shape was oblong, oval, ellipsoid and blossom end tapered among the accessions. Light green and yellowish green fruit skin colour were found at edible stage, whereas brown and yellow fruit skin colour at mature stage was found in all accessions. Edible fruit stage ranged from 73 to 85 days. Average fruit length and fruit width was 20.33 and 6.47 cm, respectively. Number of fruits per plant was ranged from 3.5 to 7.5. The highest coefficient of variation was found in fruit length (19.85 %) followed by number of fruits per plant (18.71%) and the lowest in hundred seed weight (4.71%).

Characterization of Bitter gourd Germplasm

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during 2014-15 to know the diversity of 29 germplasm of bitter gourd (*Momordica charantia* L.). Among the germplasm “uchche” (65.5%) and “korolla" (34.5%) were identified. Qualitative character variation was found in early plant vigour, plant growth habit, twining tendency, tendril branching, leaf size and peduncle separation from fruit. Elliptical (55%),oblong (4%), long cylindrical (10%), top shaped (7%) and globular (24%) fruit shape having light (17%) and deep tubercle (83%) fruit surface were exhibited. Matt (62%), intermediate (31%) and glossy (7%) fruit skin lustre were observed. Different color variations were exhibited in fruit such as green (76%) and dark green (24%). Low (14%), medium (27%) and high (59%) seediness were found among the germplasm. A good range of variations observed in fruit length (2.62 to 12.4 cm) and width (1.14 to 9.78 cm). The highest CV was found in fruit width (63.78%) and the lowest CV was found in 100 seed weight (14.57%).

Characterization of Lentil Germplasm at Ishurdi

The study was conducted at Regional Plant Genetic Resources Centre, Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2015-16 to identify the important morphological traits of lentil accession. The experiment involved 96 lentil accessions. Variations among lentil accessions were observed in different qualitative characters like plant pigmentation were observed in stems, leaves and flowers. Seedling stem pigmentation was present for 43.75% and absent for 56.25% accessions. Variations in tendril length were prominent in 62.50% and rests of the accessions were in rudimentary (37.50%). The flower ground colour was white maximum for 72.91% accessions, white with blue veins 11.45%, blue for 8.33%, violet for 3.12% and rest were in pink for 5.20% accessions. Pattern of testa was dotted for 78.12% where marbled for 18.75% and rest were in spotted for 3.12% accessions. Colour pattern of testa was grey for 13.54%, brown for 77.08% and rest were in black for (9.37 % accessions. Cotyledon colour was orange/red for 96.87% and rest were yellow for 3 accessions 3.12% accessions. Variations were observed in respect of time to flowering, time to maturity, plant height, number of seeds per pod, 100-seed weight and yield per plant among the accessions. The days to 50% flowering were earlier in BD-3805 (51 days). The earlier maturity was in BD-3812 (103 days) than the other accessions. BD-4013 produced the highest number of seeds (547) per plant. The highest seed yield (8.52 g/plant) was recorded from BD-5976 and the lowest yield (2.49 g/plant) from BD-4134 lentil accession.

Characterization of Okra Germplasm

Twenty eight accessions of okra [*Abelmoschus esculentus* L. (Moench)] showed variations in both qualitative and quantitative characters. In case of qualitative characters, all the accessions of okra showed variations in the characters except growth habit, leaf color, petal color, and fruit color at table use. These characters showed no morphological variations among the accessions i.e., all the accessions showed erect growth habit, green with red veins leaf color, yellow petal color, and green fruit color at table use. The highest variability was observed in fruit shape, leaf shape, fruit shape, and fruit pubescence at table use. All the okra germplasm also showed quantitative variations in the characters. The highest CV% was recorded from plant height (33.13) and the lowest was recorded from days to flowering (8.10). The remaining characters also showed high CV% which indicated that there were much variations present in the germplasm.

Molecular Characterization of Chilli Germplasm

This experiment was carried out with 96 germplasm of chilli at Molecular Biology Lab., Plant Genetic Resources Centre of Bangladesh Agricultural Research Institute, Gazipur. An extensive research programme had been initiated with 28 microsatellite markers for the estimation of genetic diversity, unique DNA banding pattern and duplicate identification of 96 chilli germplasm. The modified SDS and phenol: chloroform: IAA protocol found to be cost effective and latex free high quality genomic DNA was obtained successfully. All 28 microsatellite markers were found to be polymorphic. Variation was found in number of alleles, allele frequency, observed and expected heterozygosity. Using 28 primers across 96 genotypes a total of 92 alleles with an average number of 4 alleles per locus were found of which CAMS-647 showed the highest number of alleles (8) (size ranging from 191 to 275 bp) followed by 6 alleles (187 to 236 bp and 135 to 164 bp) and 5 alleles (165 to 194 bp, 239 to 289 bp, 162 to 210 bp and 230 to 302 bp) were detected at the loci CAMS-117, CAMS-679, CAMS-156, CAMS-340, CAMS-351 and CAMS-855, respectively. The primer CAMS-647 also yielded the highest number of PIC value (0.808). Genetic differentiation (Fst) values were found in the ranges from 0.201 to 1.000 with an average of 0.827 and gene flow (Nm) values ranged from 0.000 to 0.996 with an average of 0.053. Broad genetic base was found among the chilli genotypes. Over all Nei's genetic distance value from 0.106 to 1.956 among 4560 pair resulting as a means of permutation combination of 96 chilli genotypes. In the UPGMA dendrogram, among 96 genotypes of chilli 58 grouped in cluster "a" and other 38 in Cluster "b". Out of 96 genotypes, 92 genotypes were identified with at least one and/or combination of 5 primers.

Conservation of Germplasm in Active and Base Collection

Plant Genetic Resources Centre (PGRC) acts as a repository for the BARI mandate crops namely cereals (except rice), pulse, oilseed, vegetables, fruits, spices, tuber crops etc. The germplasm were conserved in medium-term storage at + 4 to + 6^{0}C and long-term storage at -18 to -22^{0}C. Generally the seeds were dried at 6-8% moisture content before storing. The centre is maintained 10157 accessions of 82 different agro-horticultural crops in the gene bank. Among them, 1752 accessions are cereals, 3514 pulses, 476 oilseeds, 3994 vegetables, 267 spices, 96 fruits and 61 other crops. Viability and seed weight of 1134 germplasm of different crops were done and two hundred sixty six (266) germplasm have been assigned new accessions. Accession/germplasm with less than 70% viability and/or less quantity of seed was regenerated.

Monitoring of Germplasm in Active Collection

Viability of 954 accessions of bottle gourd, spinach, maize, bitter gourd, sweet gourd, mung bean, muskmelon, hyacinth bean, chilli, amaranth, brinjal, snake gourd, barley, soybean, radish, and foxtail millet were tested during 2015-16 from active collection. The viability test was conducted on germination paper at 30 to 35^{0}C at dark condition for 7 to 14 days. Out of 954 accessions, 206 accessions were in <40%, 264 accessions in 40-79% and 484 accessions in 80-100% germination. Among the accessions of bottle gourd-39, spinach-16, maize-46, sweet gourd-8, mung bean-31, muskmelon-39, hyacinth bean-36, amaranth-109, snake gourd-26, barley-40, and soybean-34 were found high germination percentage (80-100%). But the germination percentage of bitter gourd, chilli, brinjal, radish, and foxtail millet were observed poor (<40%). The accessions having less than 80% germination will be regenerated in the next year.

Distribution of Germplasm

Germplasm distribution is one of the important activities of Plant Genetic Resources Centre (PGRC). The centre distributed 1067 accessions of 22 crops during 2015-2016. Among them, 30 accessions were maize, 13 okra, 3 french bean, 140 prosomillet, 90 mustard, 50 grass pea, 200 wheat, 15 field pea, 13 cowpea, 8 bitter gourd, 60 sorghum, 50 chilli, 96 lentil, 25 spinach, 122 sweet gourd, 50 mung bean, 50 chickpea, 10 soybean, 20 black gram, and 22 sunflower. Ten to hundred seeds or 5-10 g of seeds per accession were supplied to the users. The germplasm users were MS and Ph.D students, plant breeders, horticulturists, researchers, and teachers of different Universities.

Regeneration of Lentil, Linseed, Amaranth, Coriander and Fenugreek Germplasm

The experiment was conducted at Plant Genetic Resource Centre, BARI, Gazipur during 2015-16 for regeneration of twenty three germplasm of lentil (*Lens culinaris*), linseed (*Linum usitatissimum*), amaranth (*Amaranthus* sp.), coriander (*Coriandrum sativum*) and fenugreek. Some qualitative and quantitative characters were recorded for using reference data. Variations were found in the collected germplasm under each crop. Adequate amount of seeds were harvested for conservation and future use.

Regeneration of Pumpkin, Mustard, Safflower and Yard long bean Germplasm

The experiment was conducted with 35 germplasm of pumpkin (*Cucurbita moschata*), 14 germplasm of mustard (*Brassica* spp.), 3 germplasm of safflower (*Carthamu stinctorius* L.) and 13 germplasm of yard long bean (*vignasinensis var. sesquipedalis*) for regeneration and seed increase. In pumpkin, the maximum variation observed in secondary fruit skin colour; 27 cream followed by 5 yellow, 1 green, 1 orange and 1 pink. Four types of fruit shapes were found; 20 globular followed by 6 flattened, 5 oblong blocky and 4 elliptical. The germplasm of pumpkin were produced 27 to 250g seeds. In mustard, the variation was found for anthocyanin pigmentation *viz.* absent 6 and present 8 germplasm, matured leaf blade shape *viz.* elliptic 7 and ovate 7 germplasm, leaf division *viz.* sinuate 7 and lyrate 7 germplasm and seed coat colour *viz.* red brown-5 and dark brown-9 germplasm. The germplasm of mustard were produced 280 to 894g seeds. In safflower, the 3 germplasm showed oblanceolate leaf shape, deeply serrate leaf margin, dark green leaf colour, tip and few apic allocations of spines on OIB (Outer Involucral Bracts), conical head shape, yellow corolla colour in bloom, deep red corolla colour of dry flower, abundant pollen production, yellow pollen colour, cream seed colour and conical seed shape. The germplasm of safflower were produced 965 to 1452g seeds. In yard long bean, Leaf vein pigmentation was observed for only one germplasm RISA-75 and another 12 germplasm did not show leaf vein pigmentation. KASI- 35 did not show nodal anthocyanin, 12 germplasm showed nodal anthocyanin. Two types of leaf colour, intermediate green (4 germplasm) and dark green (9 germplasm) were found. One germplasm, AR-121 showed straight pod curvature and 12 germplasm were slightly carved. The germplasm of yard long bean were produced 2.17 to 195.69g seeds.

Regeneration of Brinjal, Grass pea, Vetch and Pea Germplasm

The experiment was conducted at the experimental field of Plant Genetic Resources Centre, BARI, Gazipur, during winter 2015-16 to regenerate the newly collected germplasm of brinjal-5, grass pea-4, vetch-3 and pea-8. All the germplasms were sown on 22 November, 2015 with recommended practices to get adequate quantity of seed for future use. The crops were harvested at time to time for each germplasm. Proper activities were done during drying, cleaning and curing the seed. Some qualitative data were recorded to assess the overall performance. Dark green leaf color, linear leaflet shape, blue flower color, curved pod curvature, pointed pod beak shape and immature pod color green were observed in all the germplasm of grass pea. In vetch, variations were observed in leaf color, leaflet shape, flower color and pod curvature. In pea, the germplasm showed variation in foliage color, leaflet dentation, color of standard and pod curvature. Seeds were obtained from newly collected germplasm and conserved in the genebank.

Regeneration of Spinach, Radish, Black Cumin and Soyabean Germplasm

The experiment was conducted at the experimental field of Plant Genetic Resources Centre, BARI, Gazipur during 2015-16 including some crops namely as spinach-5, radish-1, black cumin-6 and soybean-12 which were successfully grown to assist the regeneration and conservation program. All the crops except soybean were planted from 15-16 November, 2015 with recommended practices to get adequate quantity of seed for future use. The accessions of soybean were planted on 21 December, 2015. The crops were harvested at time to time for each accession. Some qualitative and quantitative characters were recorded to know the overall performance of those germplasm aiming to enrich the gene bank with good reproductive units.

Regeneration of Foxtail millet Germplasm

An experiment was conducted at the Plant Genetic Resources Centre, BARI, Gazipur during *rabi* season of 2015-16 to regenerate the 9 accessions of foxtail millet. Some of the qualitative characters were recorded for using as reference data. Some of variations were also found in all collected materials under each crop. Adequate amount of seeds were harvested for conservation and future use.

Regeneration of Musk melon, Ash gourd, Snake gourd, Sponge gourd and Indian spinach Germplasm

The experiment was conducted at Plant Genetic Resource Centre, BARI, Gazipur during 2014-15 for regeneration of fifty six germplasm of five crops. The germplasm were musk melon-6, ash gourd-14, sponge gourd-14, snake gourd-8 and Indian spinach-14. All germplasm were planted during in 2015. Recommended fertilizer doses and intercultural operation were done for using reference data. Some qualitative and quantitative characters were recorded during the regeneration of the germplasm. Harvested seeds were cleaned and maintaining high viability for future use.

Conservation of Gerplasm in Field Gene bank

PGRC is maintaining 260 germplasm (213 accessions and 47 new collections) of 72 crops both indigenous and exotic germplasm in the field genebank. The fruit germplasm are mango litchi, banana, guava, jackfruit, jujube, aonla, bael, bilimbi, bullocks heart etc. The vegetables germplsm are taro, yam, elephant foot, drumstick etc. The exotic germplasm are rambhutan, pear, tamarind, coffee, passion fruit, dragon fruit and gynura etc. The intercultural practices were done as and when necessary. Some qualitative and quantitative traits of fig, carunda, sapota and ber were recorded for using as reference data. The field gene bank has been maintained since 1985 and continued for the following years.

***In Vitro* Conservation of Potato**

This is a medium term *in vitro* conservation experiment of potato (*Solanum tuberosum* L.). The experiment was conducted with 9 varieties of potato at 22^0C to evaluate the performance of *in vitro* conservation. Nodal explants of potato varieties were cultured for 5 months on MS medium containing 20g/l sorbitol. The varieties produced 86 to 100% roots within 7 days and 90 to 100% shoots within 11 days. Number of leaves (16 to 30), shoots (6 to 14) and roots (5 to 12) were obtained from the varieties. The maximum shoot length (12.2 cm) was exhibited in BARI Alu-25 and BARI Alu-28, and the minimum shoot length (9.9 cm) was obtained from BARI Alu-37.

***In Vitro* Conservation of Mint**

The aim of the study was to increase the *in vitro* conservation period of mint (*Mentha* spp.) at 22 ± 1°C. Nodal explants of three genotypes viz. MP-1, MP-2 and MP-3 of mint were cultured on MS medium supplemented with 20 mg/l sorbitol. All the genotypes produced 100% roots within 7-9 days and shoots within 4 to 8 days. The maximum number of leaflets (89.6), shoots (8.6) and roots was observed in MP-2 and the minimum number of leaflets (47.2) and roots (3.4) was found in MP-1. The genotypes produced 5.1 to 10.6 cm shoot length with an average of 7.2 cm. The genotypes produced an average of 63 leaflets and 5.8 shoots. MP-1 performed better in minimal growth of *in vitro* conservation. This *in vitro* conservation technique can be used for conservation of mint.

Database Development for Germplasm Documentation

Passport information of 4,652 accessions on 37 crops was recorded at the Documentation Laboratory of Plant Genetic Resources Centre during 2015-16. Passport information comprising 638 accessions from cereals, 1870 accessions in pulses, 73 accessions in oilseeds, 2058 accessions in vegetables and 13 accessions in yam were documented. The centre also recorded on 5 to 55 morphological traits of 6018 accessions during 1996 to 2015. There were 780 accessions from cereals, 2,110 pulses, 253 oil seeds, 36 spices, 2708 vegetable, 71 fruits and 60 yam. Passport information were recorded in the local area network of BARI and characterization information in FAO web page. The information could be used for varietal development of different crops.

14 ON-FARM STUDIES

On-Farm Soil Fertility Management

Fertilizer and water management for chilli in the coastal ecosystem of Bhola

The experiment was conducted at MLT site, Sadar and Daulatkhan, Bhola under OFRD, Bhola in the late *rabi* season of 2014-15 and 2015-16 under AEZ-18. Three treatments viz., T_1= Soil test based fertilizer dose for high yield goal (HYG) (FRG2012) + Two irrigations at 25 and 40 days after transplanting (DAT), T_2= Soil test based fertilizer dose for HYG (FRG-2012) + three irrigations at 25, 40 and 60 DAT and T_3= Farmers' practice (Surveyed) were applied in chilli to find out an optimum fertilizer dose and irrigation frequency for higher yield of chilli. Average soil nutrient status of the experimental plots was pH- 7.4 (slightly alkaline), organic matter- 2.25 (medium), total nitrogen- 0.130% (low), P- 4.45 µg g^{-1} soil (very low), K- 0.19 meq $100g^{-1}$ soil (medium), S- 43.59 µg g^{-1} soil (very high), Zn- 0.92 µg g^{-1} soil (medium) and B- 0.55 µg g^{-1} soil (optimum). Soil test based fertilizer dose for high yield goal was 82-47-34-1 kg ha^{-1} N-P-K-Zn for treatment T_1 and T_2. Fertilizer for farmers' practice was 56-31-26 kg ha^{-1} N-P-K. Few cut worm infestation was observed in the seedling stage and it was controlled by hand picking. Fruit borer infestation was also occurred at the early fruiting stage. Insecticide Volume Flexi @ 0.5 mi lit^{-1} water was applied twice in an interval of seven to control fruit borer. No other disease or pest infestation occurred during the crop period. Average of two years' result showed that T_2 produced the highest green (9.02 t ha^{-1}) and dry chilli (2.31 t ha^{-1}) yield. The same treatment (T_2) also provided the highest gross return (Tk. 225600 ha^{-1}) and gross margin (Tk. 139785 ha^{-1}. Three irrigations along with STB fertilizer application produced MBCR 2.35 over farmers' practice in 2015-16 and it was 3.20 in 2014-15.

Integrated nutrient management for watermelon in the charland ecosystem of Bhola

The experiment was conducted at MLT site, Charfashion, Bhola under OFRD, Bhola in *rabi* season of 2014-15 and 2015-16 to know the effect of integration of nutrients for cultivation of water melon in Charland and to find out the optimum and economic fertilizer dose for water melon. Five different nutrient packages, T_1: soil test based (STB) fertilizer for high yield goal (FRG 2012) (N_{98} P_{33} K_{21} S_{10} Zn_1 B_1 kg ha^{-1}), T_2: integrated plant nutrient system (IPNS) with 5 t ha^{-1}cowdung considering T_1 (N_{50} P_{24} K_{10} S_{10} Zn_1 B_1 kg ha^{-1}), T_3: 25% higher fertilizer than T_1(N_{123} P_{41} K_{26} S_{13} Zn_1B_1 $kgha^{-1}$, T_4: T_1 + 50% higher K & Zn (N_{98} P_{33} K_{32} S_{15} $Zn_{1.5}$ $B_{1.5}$ $kgha^{-1}$) and T_5: Farmers' practice (N_{155} P_{50} K_{100} S_{30} Zn_5 kg ha^{-1}). The experiment was laid out in RCB design with six dispersed replications. As soil test value for all farmers were very close, fertilizer requirements were calculated on average. Average soil test value was N = 0.093% (low), P = 3.1µg g^{-1} soil (very low), K = 0.29 meq $100g^{-1}$ soil (optimum), S = 134µg g^{-1} soil (very high), Zn = 0.61µg g^{-1} soil (low), B = 0.33µg g^{-1} soil (medium). Hybrid variety Glory was used. Twenty-five percent higher fertilizer than soil test based (STB) dose gave the highest fruit yield (46.69 t ha^{-1}). In 2015-16, 25% higher fertilizer than soil test based fertilizer (T_3) produced the highest fruit yield (46.69 t ha^{-1}) and gross margin (Tk. 207078 ha^{-1}) due to higher yield of fruits with good size and shape. But in 2014-15, highest values of yield parameters and yield were found in IPNS based on STB fertilizer treatment (T_2).

Effect of planting technique and fertilizer management on cowpea in the coastal ecosystem of Bhola

The experiment was conducted at MLT site, Sadar and Daulatkhan, Bhola under OFRD, Bhola in the late Rabi season of 2014-15 and 2015-16 under AEZ-18. Four treatments viz., T_1: no fertilizer + recommended spacing (40 cm × 10 cm), T_2: recommended fertilizer (FRG 2012) + recommended spacing (40 cm × 10 cm), T_3: recommended fertilizer (FRG, 2012) + broadcasting and T_4: farmers' practice (No fertilizer + broadcasting) were tested to get maximum cowpea yield. The crop variety was BARI Felon-1. Seed rate was same for all four treatments (45 kg ha^{-1}). Seed sowing was done on 10-13 January, 2016. Thrips infestation was observed at flowering stage and pod borer infestation in fruiting stage. Insecticide Volume Flexi @ 0.5 mi lit^{-1} water was sprayed twice in an interval of ten days to control the insects. No other disease or pest infestation occurred during the crop period. Recommended fertilizer and spacing (T_2) produced the highest cowpea seed yield (1218 kg ha^{-1}) which was at par with T_3. The highest gross return (Tk. 54810 ha^{-1}) and gross margin (Tk. 29530 ha^{-1}) was obtained from T_2. But the highest MBCR was observed in T_3 due to higher labor cost for planting in lines maintaining recommended spacing in T_2.

Response of chickpea varieties to elite strains of rhizobium in high Barind tract

The field experiment was carried out during *rabi* season of 2015-16 at Farming System Research and Development (FSRD) Site, Kadamshahar, Godagari, Rajshahi (AEZ 26) with a view to assessing the effect of Rhizobium inoculation. Four varieties/lines of chickpea namely, BARI Chola-9, BCX-06001-11, BCX-05001-4 and BCX-05008-11 were tested with and without Rhizobium inoculation. Basal fertilizer application was made with $P_{22}K_{42}S_{20}Zn_5B_1$ kg ha^{-1} with no N application. Rhizobial inoculum 1.5 kg/ha was used for inoculation treatment. The unit plot size was 4m × 5m. The Rhizobium strain was BARI RCa-220 and the number of Rhizobium cells/g inoculant was 2.4 × 108. The seeds were coated with Rhizobium inoculum before sowing. The crop was sown on 22 November, 2015. Row to row distance was 30 cm and plant to plant was 15 cm. Inoculated plants gave significantly higher nodule number, nodule weight, stover yield and seed yield compared to uninoculated plants. Among four varieties/lines, BARI Chola-9 produced the highest nodule weight, root weight, shoot weight, seed yield and stover yield, while the highest nodule number was obtained from BCX-06001-11.

Development of fertilizer recommendation for potato-onion/maize-T.Aman rice cropping pattern in the high Ganges river floodplain

The experiment was conducted at farmers' field of Pali, Durgapur under MLT site, Shibpur, Puthia, Rajshahi during 2015-16 to study the performance of IPNS based fertilizer treatments against inorganically fertilizer based treatment on potato-onion/Maize-T. Aman rice cropping pattern in High Ganges River Floodplain. The experiment was conducted with five treatments viz. T_1: STB fertilizer dose; T_2: IPNS with5 t ha^{-1} Cowdung as of T_1, T_3: T_1+25% of NPK, T_4: IPNS with5 t ha^{-1} Cowdung as of T_3 and T_5: Farmer's practice following randomized complete block design with six dispersed replications. First year crop cycles were completed for generating data regarding performance among the treatments. The experimental soil was slightly alkaline (8.4) having low organic matter (1.78%). The soil contained 0.08% total N (very low), 25.85 ppm available P (optimum), 0.16 me% exchangeable K (low), 15.85 ppm available S (medium), 0.50 ppm available B (high) and 0.20 ppm available Zn (very low). The unit plot size was 8m × 4m. For potato, the fertilizer doses were T_1:$N_{148}P_{25}K_{106}S_{22}$ $Zn_2B_{1.5}Mg_1$; T_2: $N_{128}P_{18}K_{96}S_{22}$ $Zn_2B_{1.5}Mg_1$+5 t CD; T_3: $N_{185}P_{32}K_{132}S_{22}$ $Zn_2B_{1.5}Mg_1$; T_4:$N_{165}P_{25}K_{121}S_{22}$ $Zn_2B_{1.5}Mg_1$ + 5 t CD and T_5: $N_{240}P_{72}K_{143}S_{20}Zn_4B_2Mg_0$ + 4 t CD. Half of urea and all other inorganic fertilizers were applied according to individual plot and mixed with soil at the time of final land preparation. The rest urea was top dressed at 35 days after sowing (DAS). In case of onion, the fertilizer doses were T_1: $N_{93}P_{29}K_{85}S_{19}$ $Zn_1B_1Mg_0$; T_2: $N_{93}P_{29}K_{85}S_{19}$ $Zn_1B_1Mg_0$; T_3: $N_{116}P_{36}K_{106}S_{19}$ $Zn_1B_1Mg_0$; T_4: $N_{116}P_{36}K_{106}S_{19}$ $Zn_1B_1Mg_0$ and T_5: $N_{170}P_{76}K_{70}S_{17}Zn_4B_2Mg_0$. Half of urea and all other inorganic fertilizers were applied to individual plot and mixed with soil at the time of final land preparation. The rest urea was top dressed at 30 days after planting. Maize was planted just 2 weeks before harvesting of onion. For maize, the fertilizer doses were T_1: $N_{254}P_{30}K_{50}S_{30}Zn_1B_1Mg_1$; T_2: $N_{254}P_{30}K_{50}S_{30}Zn_1B_1Mg_1$; T_3: $N_{317}P_{38}K_{63}S_{30}Zn_1B_1Mg_1$; T_4: $N_{317}P_{38}K_{63}S_{30}$ $Zn_1B_1Mg_1$ and T_5: $N_{110}P_{16}K_{20}S_0Zn_0B_0Mg_0$. Half of urea and all other inorganic fertilizers were applied according to individual plot after harvesting of onion at 6-leaf stage of maize as side dressing followed by earthing up. The rest urea was top dressed at 10-leaf stage. In case of T. Aman rice, the fertilizer doses were T_1: $N_{66}P_9K_{20}S_{10}Zn_2B_0Mg_0$; T_2: $N_{66}P_9K_{20}S_{10}Zn_2B_0Mg_0$; T_3: $N_{83}P_{11}K_{25}S_{10}Zn_2B_0Mg_0$; T_4:$N_{83}P_{11}K_{25}S_{10}Zn_2B_0Mg_0$ and T_5: $N_{105}P_{30}K_{50}S_7Zn_3B_0Mg_0$. All the fertilizers except urea were applied as basal. Urea was applied as top dress in three equal splits at 15, 30 and 45 days after transplanting. In the first, higher rice equivalent yield was recorded from T_5 treatment followed by T_3 and T_4. IPNS based treatments resulted in lower productivity (REY), Production efficiency (PE) and economic return in terms of gross return, net return as well as BCR than that of their corresponding inorganic fertilizer based treatments.

Development of fertilizer recommendation for potato-maize-T.Aman rice cropping pattern in high Ganges river floodplain

The experiment was carried out at farmer's field under MLT site, Shibpur, Puthia, Rajshahi during 2014-15 to 2015-16 to verify the present fertilizer recommendation for Potato-Maize-T. Aman rice cropping pattern. Four treatments viz. T_1= 100% recommended fertilizer dose based on STB and HYG basis); T_2= 25% increased than T_1; T_3= 50% increased than T_1 and T_4 = Farmers' Practice (Based on surveyed) were considered for the experiment to reach the objective.

Management practices followed in Wheat-Mungbean-T. Aman rice cropping pattern.

Management factors	Potato (BARI Alu-7)	Maize (BHM-9)	T. *Aman* rice (BRRI dhan33)
Date of sowing/ transplanting	27-28/11/2015	10-12/3/2015	22-26/7/2015
Seedling age (days)	-	-	25
Unit plot size	5m × 4m	5m × 4m	5m × 4m
Spacing	60 cm × 20 cm	60 cm × 20 cm	20 cm × 15 cm
Fertilizer dose (kg ha^{-1})	T_1:$N_{148}P_{25}K_{106}S_{22}Zn_0B_2$ T_2:$N_{185}P_{32}K_{132}S_{27}Zn_0B_2$ T_3:$N_{222}P_{38}K_{158}S_{32}Zn_0B_2$ T_4:$N_{240}P_{72}K_{143}S_{20}Zn_4B_2$	T_1:$N_{254}P_{30}K_{50}S_{30}Zn_0B_0$ T_2:$N_{318}P_{37}K_{63}S_{38}Zn_0B_0$ T_3:$N_{381}P_{45}K_{75}S_{45}Zn_0B_0$ T_4:$N_{110}P_{16}K_{20}S_0Zn_0B_0$	T_1:$N_{66}P_9K_{20}S_{10}Zn_1B_0$ T_2:$N_{83}P_{11}K_{25}S_{13}Zn_1B_0$ T_3:$N_{99}P_{13}K_{30}S_{15}Zn_1B_0$ T_4:$N_{105}P_{30}K_{50}S_7Zn_3B_0$
Basal: N-P-K-S-Zn-B kg ha^{-1}	50-25-106-22-0-2	170-30-50-30-0-0	0-9-20-10-1-0
N top dress (DAT/DAS)	25 and 45 DAS,	35 DAS	15, 40 and 55 DAT
Pest control	Curative	Curative	Curative
Irrigation (DAS/DAT)	30 and 55	35, 60 and 90	-
Date of harvest	27-28/2/2016	20-22/2015	03-05/11/2015

System productivity in terms of REY was estimated for each treatment. Maximum REY was estimated in T_3 which was very close to that of T_2 and minimum in T_1 treatment. About 12.218% and 16.13% more REY in T_2 and T_3 respectively was obtained over T_1 treatment. Net return in T_3 was found as little bit higher than that of T_2. Despite of having higher gross return in T_3 but 50% higher dose of fertilizer put an extra cost to the farmers. For these consequences, higher BCR was recorded from T_2 as compared to T_3 and the lower from T_1 treatment. Similar trend was observed in 2014-15.

Response of hybrid maize to boron fertilization

An experiment was carried out at the farmers' field of MLT site, Kushtia sadar under Kushtia district during Rabi season of 2013-14 to 2015-16 to determine optimum dose of B fertilizer for increasing yield of hybrid maize and thereby farmers' income. There were six treatments such as: T_1 = 100% NPKSZn and cowdung 5 t ha^{-1} + 0 kg ha^{-1} B, $T_2 = T_1$ + 0.5 kg ha^{-1} B, $T_3 = T_1$ + 1 kg ha^{-1} B, $T_4 = T_1$ + 1.5 kg ha^{-1} B, $T_5 = T_1$ + 2 kg ha^{-1} B and $T_6 = T_1$ + 2.5 kg ha^{-1} B were used. Unit plot size was 4 m × 5 m with a spacing of 60 cm × 20 cm. Seeds were sown on 06 December, 2015. NPKS and Zn were applied @ 259 -56 -56 -33 and 6 kg ha^{-1}, respectively. One third of urea and all other fertilizers were applied as basal dose and the rest of urea were applied in two equal splits at 8-10 leaf stage and teaseling stage. Weeding was done two times at 31 days after sowing (DAS) and 51 DAS. The crop was irrigated 4 times at 31, 62, 77 and 103 DAS. The crop was harvested on 24 April, 2016. Numerically higher grain yield was obtained from T_6 followed by T_5 and T_3. The trend of yield was similar in all the years. In 2015-16, grain yield in all the treatments was low as the crop affected with storm at grain filling stage (plants laid down on the ground while some got broken). Similar trend was also found in gross return and gross margin. However, the highest MBCR (7.97) was obtained from T_2 indicating that it is more profitable than other treatments. From the above findings it may be concluded that, the treatment T_6(T_1 + 2.5 kg ha^{-1} B)is the best in consideration of grain yield, but in terms of MBCR, T_2(T_1 + 0.5 kg ha^{-1} B)is the best option.

Development of fertilizer management package for onion cultivation at Meherpur

An experiment was conducted at Mujibnagar upazila under Meherpur district during Rabi season 2015-16 to determine appropriate dose of fertilizer for high yield goal of onion and to increase crop production and farmer's income. In this experimental plot initial soil status have low organic matter contain (1.87%), moderate soil pH (7.7), very low total N (0.09%), low content of P (8.54), medium content of K (0.20) and S (17.45) where as low contain of Z (0.88) and B (0.23) were present. Four treatments namely T_1 = Soil test based Fertilizer dose for high yield goal (93-43-72-22-2.12-1.05 NPKSZn and B respectively), T_2 = T1 + 20% of T_1 (112-52-86-27-2.55-1.26 NPKSZn and B respectively), T_3 = SRC Recommendation (120-54-74-20 NPK and S respectively), T_4 = Farmers practice (346-195-150-150-26 NPKS and Zn respectively) were used. Unit plot size was 5 m × 8 m with spacing of 15 cm × 10 cm. The seeds were sown on 31 October, 2015. Fertilizers were applied as per treatments. Three times weeding and seven times irrigation were done. Pest and diseases were controlled by spraying Rovral, Entracol, Ridomil Gold and Nativo in five times of the field. The crop was harvested at 14 March, 2016. Fertilizer dose in farmers' practice (T_4) produced higher bulb yield of both BARI Piaz-4 and Suksagar. But yield was much lower as the crop affected with heavy hailstorm at pre-maturity stage that caused economic loss. It is the 1st year result. The experiment will be conducted next year for confirmation of the results.

Development of fertilizer management package for potato-bitter gourd intercropping system

The experiment was carried to find out the optimum dose of fertilizer for higher yield of local potato and bitter gourd intercropping system at farmer's field of Shamgonj, Netrakona during 2014-15. The experiment was laid out in randomized complete block design with four replications. Three levels of fertilizer viz. T_1=Recommended fertilizer dose for local variety (101-18-68-10-4 kg N-P-K-S-Zn ha^{-1}), T_2= 25% higher NPK (126-23-85-10-4 kg N-P-K-S-Zn ha^{-1}) and T_3= Farmers' practice (58-30-80 kg N-P-K ha^{-1}) were tested. Local potato variety "Challisha" and Lalteer company released bitter gourd variety "Tiya" was used in the experiment. Potato seeds were sown on 01 November, 2014 and harvested on 14 January, 2015. Seeds of bitter gourd were sown on November 04, 2014 and harvested on different dates within 10 March to 22 May, 2015. The unit plot size was 4m × 3m with spacing 25cm × 20cm along with 4 plants of bitter gourd per plot and plant to plant spacing were maintained as 2 m. T_2 gave higher yield both potato (14.95 t ha^{-1}) and bitter gourd (47.10 t ha^{-1}) whilst lowest yield was observed both for potato (12.68 t ha^{-1}) and bitter gourd (37.95t ha^{-1}) in T_3. Potato equivalent yield was highest (50.28 t ha^{-1}) in T_2 which was 22.21% higher over control. Considering the economic analysis, the same treatment T_2 that received 25% more NPK than recommended dose also provided maximum gross return and gross margin (272000 and 187460Tk ha^{-1}, respectively). But maximum marginal benefit cost ratio (MBCR) over control both for potato and bitter gourd (28.2 and 13.9, respectively) were observed in T_1.

Effect of liming on the production of cabbage

The experiment was initiated at farmers' field of Bhaluka upazila under Mymensingh district of Bangladesh during winter season of 2015-16 to find out a suitable rate of lime for cabbage production in acid soils. There are four levels of limes viz. 0.5, 1.0, 1.5, and 2.0t $CaCO_3$ ha^{-1} along with recommended fertilizer dose were compared to farmers' practice (where no lime was applied but 80-35-75-18 kg ha^{-1} NPKS were applied). The amendments of different levels of limes were done 15 days prior to planting and incorporated into the soil by ploughing. A blanket dose fertilizer was applied in each plot at the rate of 200-70-80-25-3-1 kg NPKSZn and B as per recommendation of FRG (2012). The crop variety used in the experiment was Atlas-70. The unit plot size was 3m × 2.4 m. The highest cabbage yield (92.05 t ha^{-1}) was obtained from higher rate of lime (T_4 =2.0 t ha^{-1}) while farmers' practice produced the lowest yield (78.08 t ha^{-1}). Accordingly, the maximum gross return (460243 Tk ha^{-1}) and gross return (218143Tk ha^{-1}) was recorded from T_4, while the lowest gross return (390382 Tk ha^{-1}) and gross margin (164282 Tk ha^{-1}) were obtained from T_5 (where no lime was applied). However, highest marginal benefit cost ratio (MBCR) was obtained from T_2 (where 1.0 t ha^{-1} lime was applied).

Effect of liming on the production of tomato

The experiment was carried out at farmer's field of Bhaluka upazila under Mymensingh district of Bangladesh during winter season to find a suitable rate of lime on tomato production. Four levels of limes viz. 0.5, 1.0, 1.5, and 2.0 t $CaCO_3$ ha^{-1} along with recommended dose of other fertilizers were compared with farmers' practice (no liming). Thus, five treatment combinations such as, T_1= $CaCO_3$ @ 0.5 t ha^{-1} + a blanket dose of NPK, T_2= $CaCO_3$ @ 1.0 t ha^{-1} + a blanket dose of NPK, T_3= $CaCO_3$ @ 1.5 t ha^{-1} + a blanket dose of NPK, T_4= $CaCO_3$ @ 2.0 t ha^{-1} + a blanket dose of NPK, and farmers' practice (No lime but NPKS @125-30-60-7 kg ha^{-1}) were investigated. The amendments of different levels of limes were done 15 days prior to planting and incorporated into the soil by ploughing. A blanket dose of fertilizers was applied in each plot at the rate of 150-50-80-15-2-1 kg NPKSZnB along with cow dung @ 5 t ha^{-1}as per recommendation of FRG (2012). Tomato variety BARI Tomato-14 was transplanted on 15 November, 2015. The unit plot size was 3m × 2.4m. The tomato seedlings were transplanted maintaining the spacing of 60 cm (plant to plant) and 40 cm (raw to raw) in each plot. Among the treatments, the highest rate of lime 2.0 t ha^{-1}(T_4) produced the highest tomato yield of 87.94 t ha^{-1} (which was 17.54 % higher over control) followed by T_3 (83.45 t ha^{-1}) and the lowest yield (74.12 t ha^{-1}) was obtained from farmers' practice where no lime was applied. The highest gross return (Tk. 879400 ha^{-1}) and gross margin (Tk. 638400 ha^{-1}) were also obtained from T_4. The highest marginal benefit cost ratio was obtained from the T_1 (lime @ 0.5 t ha^{-1}) as production cost was lower than T_4. However, considering higher yield and gross margin, application of lime @ 2.0 t ha^{-1} can be recommended for growing crops in acidic soils of Bhaluka area.

Effect of liming on the production of turmeric

The field experiments were conducted to find out the optimum dose of lime for maximization of yield of turmeric at farmer's field Phulbaria, Mymensingh during 2014-15 and 2015-16. Four levels of limes viz. 0.5, 1.0, 1.5 and 2.0 t ha^{-1} with control treatment (no liming as in farmers' practice) were tested along with recommended doses of fertilizer. The unit plot size was 4 m × 5 m with the spacing 50 cm × 25 cm. Soil samples from top soil (0-15 cm depth) of the experimental plots were collected before applying lime and after the harvest of crop. Turmeric variety BARI Halud-4 was used as test crop in this experiment. Each plot was uniformly fertilized with 111-38-90-22-1 kg N-P-K-S-B ha^{-1}. Different levels of lime were applied 15 days prior to crop planting and incorporated into the soil by ploughing. Seed turmeric was planted on 10-15 April, 2014 and 22 April, 2015, respectively. The crop was harvested during 8-10 February, 2015 and 29 February, 2016, respectively. Liming had significant effect on turmeric yield. Turmeric yield increased significantly due to amendment of soil acidity as compared to the control (without lime). Application of 2 t ha^{-1} of lime provided the highest turmeric yield (22.58 and 25.22 tha^{-1}) and gross margin (403660 and 459160 Tk ha^{-1}), respectively in 2014-15 and 2015-16. The lowest yield (19.51 and 19.38 t ha^{-1}) and thereby lowest gross margin (341160 and 333160 Tk ha^{-1}), respectively in 2014-15 & 2015-16 were recorded from control treatment i.e. without lime. So, liming (@ 2.0 t ha^{-1}) is needed in acidic soils of Mymensingh region for higher yield and economic return from turmeric.

Effect of organic manures on the yield and quality of potato

The effect of organic manure and chemical fertilizers on potato production was studied at the farmer's field of Shamgonj, Netrakona during 2015-16. The soil was slightly acidic (pH 6.4) and low in organic matter (1.07%) and total N (0.056%). The soil P, K, S, Zn and B contents were above the critical level (critical levels of K, P, S, Zn and B were 0.12 meq/100 ml and 7.0, 10.0, 0.6 and 0.2, respectively). Five levels of fertilizers including farmer's practice viz. T_1= RFD + 5.0 t cow dung ha^{-1}, T_2= RFD + 3.0 t poultry manure ha^{-1}, T_3= RFD + 1.5 t vermicompost ha^{-1}, T_4= RFD + 10.0 t biochar ha^{-1} and T_5= Farmers' practice (80-20-75 kg N-P-K ha^{-1}) were tested. The recommended dose of fertilizer 135-25-135-15-6-1 kg N-P-K-S-Zn and B was applied evenly all over the plot as a blanket. The unit plot size was 4m × 3m. Application of organic manure in combination with chemical fertilizers had significant effect on yield parameters and yield of potato. The maximum yield of potato was recorded from RDF + biochar treatment (T_4) which was identical with the yield obtained with RDF + vermicompost treatment (T_3). The highest gross return and gross margin (477280 Tk ha^{-1} and 275688 Tk ha^{-1}, respectively) were recorded from T_4 which was followed by T_3 treatment. So from the agronomic and economic point of view, biochar (10.0tha^{-1}) along with recommended dose of chemical fertilizers might be recommended for potato production in Netrakona.

Effect of integrated nutrient management on garlic

The experiment was conducted in the farmers' field of Trishal, Mymensingh during the *rabi* season of 2015-16 to evaluate the effect of nutrients on garlic cultivation and to find out a suitable combination of organic and inorganic fertilizers for garlic production. The experiment was laid out in RCB design with six fertilizer doses viz. Recommended fertilizer (RD) dose for HYG ($N_{100}P_{48}K_{80}S_{30}$ kg ha^{-1}), RD+ 5 t ha^{-1} cowdung, RD+ 1.5 t ha^{-1} vermicompost, Soil Test Based (STB) fertilizer dose ($N_{90}P_{42}K_{72}S_{20}$ kg ha^{-1}) + 5 tha^{-1} cowdung, STB ($N_{90}P_{42}K_{72}S_{20}$ kg ha^{-1}) + 1.5 t ha^{-1} vermicompost and farmers' practice ($N_{61}P_{36}K_{29}S_{21}$ kg ha^{-1}+ 5 t ha^{-1} cowdung). Garlic variety BARI Rashun-2 was used as test crop. It was observed that treatment STB+ 1.5 tha^{-1} vermicompost gave significantly the highest bulb yield (6.52 tha^{-1}) and the lowest yield (4.65 tha^{-1}) was found from farmers practice.

Effect of nitrogen level on kangkong

An experiment was carried out at farming system research and development (FSRD) site, Jalalpur, South Surma, Sylhet, during *Kharif* season 2015 & 2016, and at FSRD site Hazirhat, Noakhali Sadar and MLT site, Manikganj during *Kharif* season of 2015to study the effect of nitrogen level on the yield of kangkong. The variety of kangkong BARI Gimakalmi-1 was used in the trial. Five levels of nitrogen (N) fertilizer (0, 120, 170, 220 and 270 kg ha^{-1}) were used in the study. In Sylhet, the experimental soil was non-calcareous gray with low organic matter content (1.29%), low soil pH (4.2-5.4), very low total N (0.06%), low content of P (6.59), K (0.13) and S (9.14) whereas Zn (1.22) and Boron (0.48) medium and optimum, respectively. The unit plot size was 5 m × 2 m. Seeds were sown on 28 March, 2015 in Sylhet, 27 to 30 April, 2015 in Noakhali maintaining 30 cm × 15 cm spacing and 26 April, 2015 in Manikganj. Fertilizer nutrients PKS @ 40-60-10 kg ha^{-1} and CD 5 t ha^{-1} (FRG-2012) were applied. In Sylhet, 270 kg N ha^{-1} gave the highest average yield (29.46 t ha^{-1}) and gross margin (159006 Tk ha^{-1}). In Noakhali, the highest yield (42.22 t ha^{-1}) and gross margin (Tk. 116092 ha^{-1}) was obtained from 220 kg N ha^{-1}while the highest yield (40.83 t ha^{-1}) and gross margin (Tk. 245172ha^{-1}) was obtained from 270 kg N ha^{-1}in Manikganj. However, treatment N_0 produced the lowest yield and economic return at all the locations.

Effect of integrated nutrient management on soybean in the charland ecosystem of Noakhali

A field experiment was conducted at Char Jangalia under MLT site, Laxmipur, Noakhali during *rabi* season of 2015-16 to evaluate the effect of integrated nutrient management on nodulation and sustainable soybean production. Six treatment combinations viz. T_1= Control, T_2= Farmers' practice (25-15 kg ha^{-1} of N-P), T_3= 100% recommended dose (30-25-55 kg ha^{-1} of N-P-K, FRG-2012), T_4= 50 % recommended dose + 1.5 t ha^{-1} vermicompost, T_5= 50 % recommended dose + 5 t ha^{-1} compost and T_6=50 % recommended dose + 1.2 kg ha^{-1} biofertilizer were tested. The unit plot size was 4m×3m and BARI Soybean-5 was used as the test crop in this experiment. At first inoculated seeds were sown according to the experimental design for treatment $T_{6.}$ Prior to this, seeds were taken in small polythene bags equal in weight for each pot and mixed with molasses @ 20g molasses kg^{-1}seeds. For each inoculation separate plastic bags was used and care was taken to avoid contamination of the inoculated and uninoculated seeds. Then the inoculum (BINA-SB-4) was mixed with the seeds @ 20 g kg^{-1} seeds for the treatment T_6. The seeds were sown @ 60 kg ha^{-1} on18 January 2016 in line with the spacing of 30 cm × 10 cm. The crop was harvested on 20 April, 2016. There were significant differences among the different treatment combinations in terms of yield and yield contributing characters. Integrated nutrient management with application of 50% of the recommended doses of urea, TSP, MoP, and Biofertilizer (Brady Rhizobium) at the rate of 1.2 kg ha^{-1} significantly increased most of the parameters, such as the highest plant height, number of nodules per plant, pods per plant, seeds per pod and seed yield. The highest seed yield (2.93 t ha^{-1}) was recorded from plants treated with T_6 while the lowest seed yield (1.83 t ha-^{1}) was obtained from T_1. The highest gross return (Tk. 117200 ha^{-1}) and gross margin (Tk. 71840 ha^{-1}) were obtained from T_6 whereas the lowest gross return (Tk. 70400 ha^{-1}) and gross margin (Tk. 27880 ha^{-1}) was obtained from T_1. Inoculation of Brady Rhizobium seemed to help reduce the N-P-K requirement in soybean cultivation. Overall results indicated that the application of integrated nutrient management of Biofertilizer (Brady Rhizobium) with 50% N-P-K of the recommended dose would produce the maximum nodulation and higher seed yield.

Effect of fertilizers and different sowing method on the yield of linseed in coastal saline ecosystem

A field experiment was conducted at farmers' field of Killar Char, Companigonj, Noakhali which belongs to medium low land (silty clay loam) under AEZ 18f during *rabi* season of 2015-16 to know the effect of different sowing method and fertilizers dose on the yield of Linseed (variety: BARI Tishi-1) in coastal saline area. The experiment was laid out in a factorial randomized complete block design with 3 replications (compact). Two factors considered in this experiment were: A. Sowing Method (SM_1 = Relay, SM_2 = Broadcasting, SM_3 = Line sowing) and B. Fertilizers dose (FD_1= 100% Recommended dose according to FRG, 2012 for high yield goal @ 60-20-32-12 kg ha^{-1} of N-P-K-S, FD_2 = Soil test based fertilizer dose for HYG @ 47-14-23-6 kg ha^{-1} of N-P-K-S, FD_3 = Farmers' practice @ 30-35 kg ha^{-1} of N-P). The seeds were sown @ 10 kg ha^{-1} for broadcasting, 8 kg ha^{-1} for Line sowing (spacing line to line 30 cm) on 10 December, 2015. In case of relay, Linseed seeds were broadcasted in muddy land of standing T. Aman paddy fields @ 12 kg ha^{-1} during 13 to 15 November, 2015 before 15-17 days of rice (BRRI dhan40) harvest. Assume that all seeds were broadcasted in the field uniformly. Harvesting was done from 27 February, 2016 in relay sowing and 30 March, 2016 in broadcasting and line sowing. Sowing methods had significant influences on various crop characters and seed yield. Line sowing method produced higher seed yield (0.96 t ha^{-1}) which was statistically similar with broadcasting sowing method (0.95 t ha^{-1}). FD_1 (100% Recommended dose according to FRG, 2012) was superior in relation to yield (0.89 t ha^{-1}) and yield contributing characters which was statistically at par with FD_2 (0.87 t ha^{-1}). Considering the interaction effect SM_3FD_1 (line sowing method with FRG-2012 based fertilizers dose) treatment combination showed superiority in crop characters, yield attributes and yield (1.05 ha^{-1}) of Linseed than any other treatment combinations. The highest gross return (Tk.52500 ha^{-1}) was also obtained from SM_3FD_1 but highest gross margin (Tk.37626 ha^{-1}) was recorded from SM_2FD_1 treatment combination due to lower total variable cost (Tk.14374 ha^{-1}) than SM_3FD_1 treatment combination (Tk.16074 ha^{-1}). During the period of experimentation soil salinity ranged from 0.69-10.90 dS m^{-1}.

Effect of zinc and boron on lentil in the charland

The impact of different combination of zinc (Zn) and boron (B) on growth and yield of lentil (Lens culinaries L.) was studied at charland in Pabna district under AEZ-11. The experiment was consisted of ten fertilizer packages i.e. T_1= Recommended Fertilizer (RF), T_2= RF + 1 kg B + 1 kg Zn ha^{-1}, T_3= RF + 1 kg B + 2 kg Zn ha^{-1}, T_4= RF + 1 kg B + 3 kg Zn ha^{-1}, T_5= RF + 2 kg B + 1 kg Zn ha^{-1}, T_6= RF + 2 kg B + 2 kg Zn ha^{-1}, T_7= RF + 2 kg B + 3 kg Zn ha^{-1}, T_8= RF + 3 kg B + 1 kg Zn ha^{-1}, T_9= RF + 3 kg B + 2 kg Zn ha^{-1} and T_{10}= RF + 3 kg B + 3 kg Zn ha^{-1}. The experiment was designed in RCB having three replications. The variety BARI Masur-6 was selected for this study. Recommended fertilizer dose as per RF was 21-28-35-21 kg ha^{-1} N-P-K-S, respectively. The seeds of lentil were broadcasted in each plot on November 11, 2015. Lentil was harvested on February 20, 2016. Higher number of pods per plant, grains per pod, dry matter per plant and grain yield were produced at moderate higher of Zn and B doses. The highest yield (1.17 t ha^{-1}) was harvested from the treatment package RF + 2 kg B + 2 kg Zn ha^{-1}. Seed yield increased more (32.95%) in additional 2 kg B and 2 kg Zn ha^{-1} treatment and lower in RF treatment. The maximum economic return in terms of gross margin was also obtained from additional only 2 kg B and 2 kg Zn ha^{-1} treatment.

Development of fertilizer recommendation for Lentil+Mustard-B.Aus Rice-Blackgram cropping pattern in the charlands under AEZ-11

The experiment was conducted at charland of Charsadipur village of Pabna during the *rabi* season of 2014-15 to 2015-16 to determine appropriate fertilizer dose for enhancing production and income from Lentil+Mustard-B.Aus. rice-Blackgram cropping pattern. Eight fertilizer packages (T_1= 100% N-P-K-S-Zn (soil test based), T_2= 100% N-P-K-S-Zn (STB) + 25% N, T_3= 100% N-P-K-S-Zn (STB) + 25% NP, T_4= 100% N-P-K-S-Zn (STB) + 25% NK, T_5= 100% N-P-K-S-Zn (STB) + 25% PK, T_6= 100% N-P-K-S-Zn (STB) + 25% NPK, T_7= 75% N-P-K-S-Zn (STB) and T_8= Control were tested in lentil+Mustard-B.Aus.-Blackgram cropping pattern. The variety BARI Masur-6 and BARI Sarisha-14 were used in this study. The seeds of lentil and mustard were broadcasted in each plot on November 20, 2014 maintaining the same ratio of 80:20 for lentil+mustard. Two times weeding were done at vegetative stage for better growth of the crops. Rovral 50 WP @ 2.5 g L^{-1} was applied 5 times at 7-10 days interval to control stem phylum disease of lentil. Mustard and lentil were harvested on February 12 and February 21, 2015, respectively. The seeds of aus were broadcasted on 3 May, 2015 @ 50 kg ha^{-1} and the rice was harvested on 14 August, 2015. The seeds of black gram were sown in each plot having field capacity soil moisture retention at the rate of 35-40 kg ha^{-1} following broadcasting method on August 28, 2015. Two weeding were done at vegetative stage for better growth of the crops. Soil test based (STB) 100% N-P-K-S-Zn + 25% additional NPK (T_6) demonstrated better growth and yield of crops in lentil+Mustard-B.Aus.-Blackgram cropping pattern in charland of Pabna. The maximum economic return in terms of gross return (Tk.225960 ha^{-1}) and gross margin (Tk. 87465 ha^{-1}) were also recorded in the same fertilizer package (T_6).

Effect of ash as a source of potassium and silica on yield of wheat under heat stress environment

The experiment was conducted at farming systems research and development (FSRD) site, Pushpapara, Pabna during the *rabi* season of 2014-15 and 2015-16 and on station, BARI Rangpur and Agricultural Research Station, Rajbari, Dinajpur during the *rabi* season of 2015-16to assess the effect of ash as a source of potassium and silica on yield traits and yield of wheat. The experiment consisted of six different treatments viz. T_1= recommended dose of fertilizer nutrients (FRG, 2012), T_2= T_1+ 25% extra K, T_3= T_1+ 1 t ash ha^{-1}, T_4= T_1+ 1.25 t ash ha^{-1}, T_5 = T_1+ 1.5 t ash ha^{-1} and T_6= control. In Dinajpur, the soil texture of the land was silty loam. The pH, organic matter, total N, available P, K, S, Zn and B were 6.66, 1.71 %, 0.085%, 24.19 µg/g soil, 0.21meq/100 g soil, 24.04 µg/g soil, 1.31 µg/g soil and 0.84 µg/g soil, respectively. In Pabna, the organic matter, total N, available P, K, S and Zn were 1.71 %, 0.10%, 3.0 µg/g soil, 0.29 meq/100 g soil, 3.5 µg/g soil and 0.77 µg/g soil, respectively. In Rangpur, the pH, organic matter, total N, available P, K, S, Zn and B were 5.54, 1.24%, 0.06%, 80.50 µg/g soil, 0.14meq/100 g soil, 5.43 µg/g soil, 1.0 µg/g soil and 0.10 µg/g soil, respectively. BARI Gom-26 was used in the study. The unit plot size was 8 m x 5 m. The seeds were broadcasted on December 02- 03, 17 and 07, 2015 in Pabna, Rangpur and Dinajpur maintaining seeding rate of 120 kg ha^{-1}, respectively. The crop was harvested on 15- 23 March 2016 in Pabna and Dinajpur and 05 April 2016 in Rangpur. Higher grain yield was obtained from all levels of ash plus RF. Significantly higher grain yield was obtained from 1.25 and 1.5 t ash ha^{-1} + RF followed by 1.0 t ash ha^{-1} + RF and 25% K + RF while lower yield was attained from control. In Pabna and Rangpur maximum economic return in terms of gross return and gross margin were obtained from 1.25 t ash ha^{-1} plus RF. In Dinajpur, maximum economic return in terms of gross return and gross margin were obtained from 1.0 t ash ha^{-1} plus RF. Flag leaf chlorophyll content (SPAD value) showed positive relationship with grain yield whereas canopy temperature showed negative relationship. Therefore, incorporation of 1.25-1.5 ton ash ha^{-1} plus RF in soil seems promising for higher grain yield and economic return of wheat under heat stress environment.

Effect of ash as a source of silica and potassium on lentil

The experiment was conducted at multilocation testing (MLT) site Atghoria, Pabna during the *rabi* season of 2015-16 to ascertain the response of rice husk ash in controlling disease and seed yield of lentil. Different treatments (RF, RF +1.0 t ash ha^{-1}, RF + 1.5 t ash ha^{-1}, RF + 2.0 t ash ha^{-1}, RF + commercial fungicide and farmers' practice) were tested. The unit plot size was 10m x 8m. The dry rice husk ash was collected from local rice mill and incorporated in soil as per treatment specification during final land preparation. After preparing the land the seeds of BARI Masur-7were broadcasted on November5-7, 2015 in the experimental plot maintaining 40 kg ha^{-1}seed rate. Fertilizer management was done with the application of 18-30-27-18-1-1 kg N-P-K-S-Zn-B ha^{-1}. The crop was harvested on February 25, 2016. The incorporation of different rate of rice husk ash plus recommended fertilizer and RF plus commercial fungicide resulted in better performance in yield traits and higher seed yield of lentil while farmers' practice showed the lowest seed yield. Relatively lower prevalence of stem phylum blight was also investigated under ash management in lentil.

Effect of ash as a source of silica and potassium on mustard

The experiment was conducted at multilocation testing (MLT) site Atghoria, Pabna during the *rabi* season of 2015-16 to ascertain the response of rice husk ash in controlling disease and seed yield of lentil. Different treatments (RF, RF +1.0 t ash ha^{-1}, RF+1.5 t ash ha^{-1}, RF + 2.0 t ash ha^{-1}, RF+ commercial fungicide) were tested. BARI Sarisha-14, a popular short duration mustard variety was used in this study. The unit plot size was 10m × 8m. The dry rice husk ash was collected from local rice mill and incorporated in soil as per treatment specification during final land preparation. After preparing the land the seeds of BARI Sarisha-14 were broadcasted on November, 2015 in the experimental plot maintaining standard seed rate. Fertilizer management was done using 90-27-32-15-

1-1 kg N-P-K-S-Zn-B ha-1**.** The crop was harvested on February 10, 2016**.** Incorporation of different rate of rice husk ash plus recommended fertilizer resulted in better performance in yield traits and the highest seed yield of lentil followed by RF plus commercial fungicide while only recommended fertilizer showed the lowest seed yield. Relatively lower prevalence of stem phylum blight was also investigated under ash and commercial fungicide management in lentil**.**

Effect of integrated nutrient management on the yield and quality of sweet pepper

The experiment was carried out at the research field of Agricultural Research Station, On-farm Research Division, Rangpur to investigate the effect of integrated nutrient management on the yield and quality of sweet pepper. There were six treatments: T_1 = 100% RD ($N_{115}P_{70}K_{125}S_{20}Zn_2$ kg ha^{-1}), T_2 = 75% RD + 5 t ha^{-1} CD, T_3 = 75% RD + 5 t ha^{-1} CD Slurry, T_4 = 75% RD + 3 t ha^{-1} PM, T_5 = 75% RD + 3 t ha^{-1} PM Slurry, T_6 = Native fertility. The tested variety was BARI Misti Morich-1. The experiment was laid out in RCBD with 3 replications. The unit plot size was 3m × 1m. Thirty-five days old sweet pepper seedlings were transplanted at the spacing of 50cm × 50cm on 13 December, 2015. The crop was harvested four times after the fruit attained maturity. T_5 (75% RD+ 3 t ha^{-1} PM Slurry) produced the highest fruit yield (23.55 t ha^{-1}) and the lowest yield (17.10 t ha^{-1}) was in control treatment (native fertility). An inclusion of 3 t PM Slurry ha^{-1} with 75% RD can reduce 25% of chemical fertilizer. Integrated use of PM Slurry at the rate of 3 t ha^{-1} with 75% RD chemical fertilizers was found as the best combinations in respect of sweet pepper yield and probable of enriching the soil organic matter.

Fertilizer management for potato/sweet gourd-maize-t.aman rice cropping pattern

The trial was conducted at on station of the OFRD, BARI, Alamnagar, Rangpur during 2014-15 to find out suitable fertilizer management practice for Potato/Sweet gourd-Maize-T.Aman rice cropping pattern. There were five treatments viz., T_1=Soil Test Based dose, T_2=High yield goal based on FRG, 2012, T_3=25% higher of FRG’ 2012 based dose, T_4=25% lower of FRG’ 2012 based dose, T_5=Farmer’s practice. Higher potato yield (31.76 t ha^{-1}) was recorded in T_3 followed by T_5 (31.57 t ha^{-1}) and T_2 (30.92 t ha^{-1}) while the lowest yield was observed in T_4 (29.11 t ha^{-1}). The yield of sweet gourd varied significantly ranging from 32.86 to 39.07 t ha^{-1}. Statistically the highest maize yield (6.26 t ha^{-1}) was recorded in T_3 and the lowest was counted from T_4 (4.94 t ha^{-1}). The highest grain yield of T. Aman rice was recorded in T_3 (3.47 t ha^{-1}) and the lowest from T_4 (2.89 t ha^{-1}). The highest gross return was estimated in T_3 (Tk. 703520 ha^{-1}) and the lowest was obtained from T_4 (Tk. 618316 ha^{-1}). The highest gross margin was estimated in the treatment T_2 (Tk.386616ha^{-1}) and the lowest gross margin (Tk. 320960 ha^{-1}) was estimated in T_4 treatments.

Effect of organic compost in combination with chemical fertilizers on the yield of tomato in charland ecosystem of Jamalpur

An experiment was carried out at the farmers’ field of multi-location testing site, Malancha, Melandah, Jamalpur during *rabi* season of 2014-15 and 2015-16 to know the effect of vermicompost and kitchen waste compost on winter tomato under charland condition. Tomato variety BARI Tomato-14 was used in the study. Four treatments viz. T_1=Recommended dose of Chemical fertilizers (RD), T_2=Vermicompost 1.5 t ha^{-1} + $^2/_3{}^{rd}$ RD, T_3= Kitchen waste 3 t ha^{-1} + $^2/_3{}^{rd}$ RD and T_4= Farmers' practice were used in the study. The seeds of tomato variety BARI Tomato-14 were sown in seed bed on 10 October, 2014 and 10-12 October, 2015 while seedlings were transplanted in main field on 19 November, 2014 and 19-21 November 2015, respectively in the 1st and 2nd year. The unit plot size was 1m × 5m accommodating 20 plants in each plot having 50 cm × 50 cm plant spacing. Fruits were harvested in the 1st year during 22 February to 15 March, 2015 and in the 2nd year during 24 February to 20 March, 2016. Two-year results showed that application of organic compost significantly influenced the yield and yield attributes of tomato in the charlands. Treatments having organic compost along with $^2/_3{}^{rd}$ of recommended chemical fertilizers (T_2 and T_3) produced significantly higher yield than that of treatment with full dose of recommended fertilizers (T_1) as well as farmers' practice (T_4). Performance of vermicompost was much better than kitchen waste compost as produced significantly higher yield in both the years. In terms of yield and economic return, T_2 (Vermicompost 1.5 t ha^{-1} + $^2/_3{}^{rd}$ RD) was the best as provided the highest yield (87.43 and 88.55 t ha^{-1}, respectively in 2014-15 and 2015-16), gross return (Tk. 6,12,010 and 7,08,400 ha^{-1}, respectively in 2014-15 and 2015-16) and gross margin (Tk. 5,05,230 and 5,18,955 ha^{-1}, respectively in 2014-15 and 2015-16).

Effect of organic compost in combination with chemical fertilizer on the yield of brinjal under charland ecosystem of Jamalpur

An experiment was carried out at the multi-location testing site, Malancha, Melandah, Jamalpur during November, 2015 to March, 2016 to know the effect of vermicompost and kitchen waste compost on brinjal. The local variety (Bottle begun) was used in the study. Four treatments viz. T_1=Recommended dose of Chemical fertilizers (RD), T_2=Vermicompost 1.5 t ha^{-1} + $^2/_3{}^{rd}$ RD, T_3= Kitchen waste 3 t ha^{-1} + $^2/_3{}^{rd}$ RD and T_4= Farmers' practice were used in the study. The seeds of brinjal were sown in the seed bed on 10 October 2015. Seedlings were transplanted in the main field on 19 November 2015. The unit plot size was 1m × 5m accommodating 20 plants in each plot having 50 cm × 50 cm plant spacing. Fruit harvest started on 22 February, 2015 and continued up to 15 March, 2015. Both type of compost in combination with chemical fertilizer produced significantly higher yield of brinjal compared to recommended dose of chemical fertilizers only. Vermicompost performed better than kitchen waste compost as produced significantly higher yield. Vermicompost 1.5 t ha^{-1} along with $2/3^{rd}$ of recommended doses of fertilizers provided the highest yield of brinjal and economic return as well. This is 1st year results, the experiment may be repeated in the next year for confirmation of the results.

Effect of organic compost in combination with chemical fertilizers on the yield of summer bottle gourd in charlands of Jamalpur

An experiment was carried out at the Farming System Research and Development site, Kushumhati, Sherpur during 2015 to know the effect of vermicompost and kitchen waste compost on summer bottle gourd. The variety BARI Lau-4 was used in the study. Four treatments viz. T_1=Recommended dose of Chemical fertilizers (RD), T_2=Vermicompost 1.5 t ha^{-1} +$2/3^{rd}$ RD, T_3= Kitchen waste 3 t ha^{-1} + $2/3^{rd}$ RD and T_4= Farmers' practice were tested in the study. Application of organic compost significantly influenced the yield and yield attributes of bottle gourd in the charland. The seeds of BARI Lau-4 were sown in the pit on March 31, 2015. The unit plot size was 6m × 2m accommodating 3 plants in each plot having 2 m × 2 m plant spacing. The crop harvesting was started on June 16, 2015 and continued up to July 9, 2015. Treatments having organic compost along with $2/3^{rd}$ of recommended chemical fertilizers (T_2 and T_3) produced significantly higher yield than that of treatment with full dose of recommended fertilizers (T_1) as well as farmers' practice (T_4). Performance of vermicompost was much better than kitchen waste compost as produced significantly higher yield. In terms of economic return, T_2 (Vermicompost 1.5 t ha^{-1} +$2/3^{rd}$ RD) was most profitable as provided the highest gross return (Tk. 3,51,440 ha^{-1}) and gross margin (Tk. 1,87,276) while farmers' practice gave the lowest gross return (Tk. 2,06,080ha^{-1}) and gross margin (Tk. 59,390 ha^{-1}).

Effect of different fertilizer packages on the yield of chilli at charlands of Jamalpur

The experiment was carried out to develop fertilizer recommendation for chilli at charland of Jamalpur at the Multi-Location testing site, Melandah, Jamalpur during October, 2015 to March, 2016 to develop the fertilizer recommendation for chilli at charland of Jamalpur as well as higher yield and maximum economic return.. Local variety (Balijori morich) was used in the study. Five treatments were included in the study these were, T_1=Recommended dose of chemical fertilizers (RD) (N_{100}, P_{65}, K_{100}, S_{32}, $B_{2.0}$ kg/ha), T_2= Soil test based fertilizer dose (STB) (N_{93}, P_{51}, K_{58}, S_{16}, $B_{0.9}$ kg/ha), T_3= 125% STB based fertilizer dose (N_{116}, P_{64}, K_{73}, S_{20}, $B_{1.13}$ kg/ha), T_4= Integrated plant nutrient system (IPNS) (N_{70}, P_{44}, K_{47}, S_{17}, $B_{0.9}$ kg/ha), based fertilizer dose+5 t CD/ha, T_5= Farmers' practice (N_{73}, P_{40},

K_{50}, S_{14} kg/ha. The seeds of chilli were sown in broadcast on October 05, 2015. The unit plot size was 6m x 5m. The crop harvesting was started on 26 February, 2015 and continued up to 13 March 2016. Results indicated that IPNS based fertilizer dose+5 t CD/ha significantly influenced chilli production. A wide range of variation was observed among the treatment combinations. The highest dry yield (4.51 t ha^{-1}) was recorded from IPNS based fertilizer dose + 5 t CD ha^{-1} and the lowest dry yield (2.67 t ha^{-1}) was obtained from farmers' practice.

Validation of fertilizer management formukhikachu at charlands of Jamalpur

An experiment was carried out to validate of fertilizer management on mukhikachu at the Multi-Location testing site, Malancha, Melandah, Jamalpur during 2015 to verify the fertilizer dose for *mukhikachu* in farmer's field. BARI Mukhikachu-1 (Bilashi) was used in the study. Three treatments were included in the study these were, T_1= 96-27-81-18 kg/ha NPKS as per FRG'2012, T_2= 120-34-101-23 kg/ha NPKS (25% higher), T_3= Farmers' practice (112-20-50-9 kg/ha NPKS). The seeds of mukhikachu were sown on February 23, 2015. The unit plot size was 5m × 3.6m having 60 cm × 30 cm plant spacing. The crop was harvested on October 13, 2015. Results clearly indicated that 120-34-101-23 kg/ha NPKS (25% higher) significantly influenced mukhikachu production. A wide range of variation was observed among the treatment combinations. The highest yield (30.36 t/ha) was recorded from T_2=120-34-101-23 kg/ha NPKS (25% higher) and the lowest yield (16.59 t/ha) was obtained from farmers' practice.

Production of bottle gourd twigs and leaves as influenced by nitrogenous fertilizer management in Tangail

An experiment was conducted in the farmers' field at the FSRD site, Elenga, Tangail during the *rabi* season of 2015-16 to find out the optimum dose of nitrogen and best method of its application for yield maximization of bottle gourd for leaf purpose and to increase production and farmers' income in Tangail region. The treatment comprised three nitrogen levels (N_1= 60 kg N ha^{-1}, N_2= 80 kg N ha^{-1} (100%) and N_3= 100 kg N ha^{-1}) and two application methods (M_1= One third of the dose applied at 2-3 leaf stage and the rest after each cut in equal splits and M_2= Full dose after each cut in equal splits at 5 times). The seeds were sown on 14 to 19 October, 2015. Weeding and all other intercultural operations were done as and when necessary. The twigs were harvested five times (at 12-15 days interval). Harvesting was started from 35 DAS and it continued up to 95 DAS. Twigs were sold as bundles and each bundle contained six twigs. Among the treatments combinations the highest twig yield (46.85 t ha^{-1}) and gross margin (Tk. 699831 ha^{-1}) was obtained from M_1 method along with the highest level of nitrogen (N_3=100 kg N ha^{-1}).

Effect of fertilizer management on flower yield of gladiolus

The experiment was conducted at MLT site Jhikargacha, Jessore during *rabi* season 2014-15 and 2015-16 to find out the optimum fertilizer dose for gladiolus. Four different fertilizer doses were used in the experiment viz. T_1=100% NPKSZnB (STB), T_2= Cowdung 5 t ha^{-1} + IPNS basis inorganic fertilizer, T_3= T_1+ 25% higher NPKSZnB, T_4 = Farmers' practice (N-P-K-S-Zn-B @ 155-75-95-48-5.50-1 t ha^{-1} and cowdung 5 t ha^{-1}). The 100% NPKSZnB (STB) was 172-36-93-28-1- 0.5 kg/ha. Gladiolus local was used as test crop. The unit plots size was 3m × 2m. The land was well prepared and seeds were sown maintaining row to row spacing 20 cm and plant to plant 15 cm on 20 November 2014 and 15 November 2015. The crop was harvested on 16 to 19 February 2015 and 07 to 19 February 2016. The highest number of florets (14.40 and 12.67) and leaves (11 and 10.33) were found inT_1, respectively in 2015-16 and 2014-15 followed by T_2 and T_3 and these were lowest in farmers' practice (T_4). Gross margin and benefit cost ratio were the highest in T_1 and the lowest values were recorded from T_4 in both the years.

Effect of fertilizers on mustard grown as relay crop with T.Aman rice

The experiment was conducted at MLT site Jhikargacha, Jessore during *rabi* season 2015-16 to find out the optimum fertilizer dose for mustard as relay cropping with T. Aman rice. Three different fertilizer doses were used in the experiment viz. T_1=BARI recommended dose, T_2= Half of BARI recommended dose and T_3= Farmers' dose. The experiment was laid out in a randomized complete block design with five replications. Mustard variety BARI Sarisha-15 was used as test crop. The unit plots size was 8m × 5m. Seeds were sown in T.Aman rice before 07 days of harvesting on 08-11 November 2015. The crop was harvested on 04 to 08 February 2016. BARI recommended fertilizer dose showed highest (1192 kg ha^{-1}) yield of mustard followed by half of BARI recommended fertilizer dose and this was the lowest (760 kg ha^{-1}) from farmers' dose. Yield contributing characters of mustard were also performed better in BARI recommended dose. The highest gross margin (Tk. 16920 /ha) and benefit cost ratio (1.46) was found in BARI recommended dose and these were the lowest from farmers' dose.

Productivity of bt-brinjal as influenced by different types of compost along with chemical fertilizer in IPNS

The experiment was conducted at RARS, Jessore during *rabi* season 2015-16 to find out a suitable combination of compost and chemical fertilizers for maximizing the yield of Bt-brinjal and economic benefit as well as maintain soil health. The experiment was laid out in RCB design with three replications. Six fertilizer packages viz., T_1:100% RDF based on STB (FRG, 2012) from chemical fertilizer, T_2: 125% RDF based on STB (FRG, 2012) from chemical fertilizer, T_3: 75% from chemical fertilizer + 25% from FYM compost, T_4: 75% from chemical fertilizer + 25% from vermi-compost, T_5: 75% from chemical fertilizer + 25% from chemical treated compost and T_6: Farmers' practice were tested. Bt-Brinjal-3 (Nayantara) was used as test material. The unit plot size of the experimental plot was 3m × 4m. Seedling was planted in a line maintaining a spacing of 60 cm × 40 cm on 15 December, 2015 after the tillage operation flowing proper dozes of fertilizer. The crop was harvested during 25 February to 8 May, 2015. Different fertilizer packages did not influence yield and yield parameters of bt-Brinjal significantly. However, higher yield and gross margin (17.29 t ha^{-1} and 55,997 Tk. ha^{-1}) was obtained from farmers practice (T_6) followed by T_2 (15.63 tha^{-1}and 52,661 Tk. ha^{-1}), while the lowest one (13.05 tha^{-1} and 24,568 Tk. ha^{-1}) from T_1. The 100% of soil test based recommended fertilizer dose as per FRG, 12 either as chemical fertilizer or combination of chemical and organic fertilizers produced lower yield than higher doses of fertilizers in T_2 (125% of RDF) and Farmers' practice (nearly double of RDF) indicates that bt-Brinjal needs higher amount of nutrients to produce optimum yield. Though farmers' practice (T_6) and T_2 with higher dose of chemical fertilizers produced somewhat higher yield and economic benefit but not friendly to soil health in the long run. On the other hand, combination of chemical and organic fertilizer i.e. T_3, T_4 and T_5 (75% from STB RCF + 25% from compost) produced statistically similar yield to that of farmers' practice suggestive of better options for increasing yield of Bt-Brinjal. So, combined application of organic and chemical fertilizers is needed for long term cultivation of Bt-brinjal. This is first year result. So at least two more years' experimentations with some modifications in treatments needed to draw a final conclusion.

Effect of fertilizer management techniques on the performance of winter maize under zero tillage cultivation

The experiment was carried out at FSRD site, Pushpopara, Pabna during 2015-16 cropping season to see the performance of maize under zero tillage conservation system as well as to identify the suitable dose and appropriate placement technique of fertilizer for zero tillage maize cultivation. Five different treatments viz, T_1= Recommended dose *(*350-55-80-35-2-2 NPKSB kg ha^{-1}*)* + Broadcast application, T_2= T_1 + 10*%* extra fertilizer, T_3= Recommended dose *(*350-55-80-35-2-2 NPKSB kg ha-1*)* + Furrow placement, T_4= T_3 + 10*%* extra fertilizer and T_5= Control were tested on maize variety NK-40. The unit plot size was 24 m^2. The seeds were sown on 23 November, 2015 through dibbling method. The remaining 1/3 N was applied after first irrigation on 2 January, 2016. NK-40 was used in the study. The crop was harvested on 28 April, 2016. Significantly higher grain yield was obtained from all the treatment combinations while lower yield was found in farmers' practice. Maximum economic benefit in terms of gross return and gross margin was obtained from RF plus 10 % extra fertilizer through furrow application which was followed by RF with furrow application under zero tillage condition.

Effect of ash as a source of silica and potassium on maize under drought condition

The experiment was conducted at farming systems research and development (FSRD) site, Pushpopara, Pabna during the *rabi* season of 2015-16 to evaluate the effect of ash on maize. The experiment comprised of five different treatments viz. T_1= Well-watered + Recommended dose (350-55-80-35-2-2 NPKSB kg ha^{-1}) of fertilizer as FRG, 12, T_2= Water-stressed (water withdraw after anthesis)+ Recommended dose of fertilizer, T_3= T_2 + 20% extra K, T_4= T_2 + 1.0 t ha^{-1} ash and T_5= T_2 + 1.5 t ha^{-1} ash. BARI hybrid maize-9 was used in the study. The unit plot size was 20 m^2. The seeds of BARI hybrid maize 9 were sown on 6 December, 2015. The crop was harvested on 10 May, 2016. Well water along with recommended fertilizer management always sustained better performance of morpho-physiological and yield contributing traits as compared to water stress along with recommended fertilizer. However, silicon management under water stressed treatment exhibited equal performance regarding morpho-physiological and yield contributing traits which eventually improved sink growth and finally increased grain yield of maize.

Response of muskmelon to chemical fertilizers at charlands in Faridpur

A study was conducted during the *Kharif-I,* 2016 at the farmer's field of Sadarpur upazila, Faridpur to find out an optimum and economically viable chemical fertilizer dose for maximum yield of muskmelon. The experiment was set up in Randomized Complete Block Design with four dispersed replications. Six treatments were considered in the study such as: T_1= HRC recommended dose of chemical fertilizers ($N_{60}P_{20}K_{30}S_{15}Zn_1B_1$ kg ha^{-1}), T_2= $N_{75}P_{25}K_{38}S_{20}Zn_{1.25}B_{1.25}$ kg ha^{-1} (T_1+25% of T_1), T_3= $N_{90}P_{30}K_{45}S_{23}Zn_{1.5}B_{1.5}$ kg ha^{-1} (T_1+50% of T_1), T_4= $N_{45}P_{15}K_{23}S_{11}Zn_{0.75}$ $B_{0.75}$Kg ha^{-1} (75% of T_1), T_5= $N_{100}P_{40}K_{28}S_{17}Zn_{3.5}B_{1.7}$ kg ha^{-1} (Farmer's practice), T_6= Native nutrient (control). Local variety of muskmelon was used. The unit plot size was 5 m × 5 m. Seeds were sown in pit on 18 to 20 April, 2016 maintaining a spacing of 2.5 m from pit to pit. The highest fruit yield (22.22 t ha^{-1}) was recorded from T_2 might be due to producing maximum number of fruits $plant^{-1}$. The lowest fruit yield (1.09) was obtained from control plot for performing the lowest in all yield contributing parameters. The highest gross return of Tk. 68143 ha^{-1} was found from T_2 (T_1+25% of T_1) due to the highest yield and the lowest gross return Tk. 34551 ha^{-1} was obtained from the absolute control treatment (T_6). The maximum benefit cost and ratio (1.64) was also recorded in T_2 and the lowest in absolute control treatment.

Improvement of Cropping System

Development of four crop based cropping patterns against farmers existing pattern in different agro-ecological zones of Bangladesh

The present experiment was conducted at 15 different FSRD and MLT sites of the country under On-Farm Research Division during 2015-16 to increase cropping intensity and productivity through rice based cropping system, to sustain food security, poverty eradication and livelihood improvement of ever increasing population and to increase farmer's income, access to food and nutrition, employment generation and woman's participation in agriculture. A total of 12 different alternative cropping patterns with their existing patterns were tested. The cropping patterns tested with their location are given below:

Table 1. List of alternative cropping patterns tested in different locations

Sl.#	Alternative cropping pattern	Farmers existing pattern	Location
1.	Mustard-Boro-T.Aus-T.Aman	Boro-T.Aman Mustard-Boro-T.Aman	Mymensingh, Dinajpur Rangpur, Khulna, Sherpur Pabna, Comilla, Bogra (8)
2.	Lentil-Mungbean-T.Aus-T.Aman	Boro-T.Aman Lentil-Jute-T.Aman Lentil-Sesame-T.Aman Lentil-Mungbean-T.Aman	Rajshahi, Faridpur, Kushtia, Pabna (4)
3.	Potato-Boro-T.Aus-T.Aman	Boro-T.Aman Potato-Boro-T.Aman	Dinajpur, Tangail , Rangpur, Comilla (4)
4.	Mustard-Mungbean-T.Aus-T.Aman	Lentil-Sesame-T.Aman	Kushtia (1)
5.	Wheat- Mungbean-T.Aus-T.Aman	Lentil-Sesame-T.Aman	Kushtia (1)
6.	Mustard-Boro-Jute-T.Aman	Mustard-Boro-T.Aman	Tangail (1)
7.	Potato-Vegetable*-Jute-Blackgram	Tobacco-Jute-Blackgram	Tangail (1)
8.	Mustard-Onion-T.Aus-T.Aman	Onion-Jute-T.Aman	Faridpur (1)
9.	Garden pea- Boro-Jute-T.Aman	Mustard-Boro-T.Aman	Pabna (1)
10.	Onion/Mungbean-Jute-T.Aman	Onion-Jute-T.Aman Rice	Kurigram (1)
11.	Potato-Mungbean-Jute-T.Aman	Potato-Jute-T.Aman Rice	Nilphamari (1)
12.	Potato/Sweetgourd-T.Aus-T.Aman	Boro-T.Aman Rice	Kurigram (1)

* Amaranth, Indian spinach and gimakolmi

The result revealed that the alternate four crop cropping patterns could be established successfully with short duration varieties. Alternate cropping patterns was agronomically and economically more profitable than the existing patterns. Rice equivalent yield, productivity and profitability was higher than the farmers' existing cropping patterns. Rice equivalent yield of the farmers existing pattern varied from 8.54 to 34.22 whereas in the alternate improved cropping patterns it ranged from 14.66 to 43.24. Inclusion of new crops in the existing cropping pattern and replacing old and traditional varieties by modern improved varieties enhanced productivity and profitability.

The productivity and economic return of the improved four crop based patterns was higher as compared to farmer traditional patterns suggesting that improved pattern is more profitable than farmers pattern. The turn around time can be minimized about 134-136 days by practicing four crop production in a year. So total crop production and cropping intensity can be increased with four crop based cropping pattern. The higher rice equivalent yield, gross return and gross margin was found in the alternate cropping patterns compared to existing patterns due to additional yield of included crops. So crop cultivation in alternate cropping pattern would help increase total production, farmer's income and employment opportunity.

Four crops based cropping pattern Mustard (BARI Sarisha-14)-Boro (BRRI dhan28)-T.Aus (BRRI dhan48)-T.Aman (BRRI dhan62) is agronomically feasible and economically profitable compared to the existing farmers cropping pattern Boro-T.Aman or Boro-T.Aus-T.Aman. On an average, 335-345 days required to complete one cycle of alternate cropping pattern. Lentil and mungbean are included in the pattern which can meet up vegetable protein of farm families. Pulse crops produce nodule in their root system which contribute to enrich soil fertility. Lentil-Mumgbean-T.Aus-T.Aman is a promising cropping pattern for higher productivity and profitability. The replacement of boro rice and incorporation of short duration aus rice in improved pattern reflects environment friendly and more productive practice. It can also increase soil health by inclusion of mungbean. Improved cropping pattern Mustard (BARI Sarisha-14) - Boro (BRRI dhan28) - Jute (0-9897) - T.Aman (BRRI dhan57) is also a profitable technology for Tangail region. The improved pattern Gardenpea-boro-T.Aus-T.Aman rice exhibited better performance as compared to farmers existing pattern Mustard-boro-T.Aman rice.

Incorporation of garden pea in improved pattern indicate a nutrient smart technology. Potato/sweet gourd-T.Aus-T.Aman could be a suitable cropping pattern in stable char land with higher return. Besides, boro rice needs more irrigation due to sandy loam soil in the existing pattern. It can be concluded that cultivation of alternate cropping patterns is profitable than that of existing patterns. So cultivation of alternate cropping patterns would help increase total production, farmer's income, improve soil health and reduce nutritional imbalance of human being.

Cropping intensity and productivity increased by adopting short duration varieties of rice specially T.Aus (BRRI dhan48), T.Aman (BRRI dhan62, BRRI dhan57, Binadhan-7), mustard (BARI Sarisha-14), potato (BARI Alu-7) and mungbean (BARI Mung-6) in the existing cropping system. Cultivation of 4 crops in a year increased crop productivity but it is difficult to establish T.Aus rice due to labour crisis and sometimes for lacking of irrigation. Mechanized planting and harvesting can solve the problem. Sometimes market price of rice is low to compensate the production cost, especially high labour and irrigation cost. If rice price can be optimized four crop based cropping patterns will be more popularized.

Development of alternate cropping pattern through Garden Pea-Fallow-T.Aman against T.Aman-Fallow-Fallow

The experiment was conducted at the MLT site, Dumuria, Khulna under AEZ-13 during 2015-16 to improve the productivity of existing cropping pattern Fallow-Fallow-T.Aman by introducing new garden pea variety (var. BARI Motorshuti-3) for higher yield and economic returns to the farmers. The improved cropping pattern Garden pea-Fallow-T.Aman gave the highest gross return (Tk. 281600 ha^{-1}) and gross margin (Tk. 192316 ha^{-1}) with MBCR 5.49.

Agronomic management practices and economic analysis of the crops for the existing and alternate cropping pattern Garden pea-Fallow-T.Aman at the MLT site, Dumuria during 2015-16.

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Fallow	Fallow	T.Aman	Garden pea	Fallow
Variety	Local (*Jamai Babu)*	-	-	Binadhan-7	BARI Motorshuti-3	-
Spacing	20x20	-	-	20 x15	30 cm row distance	-
Unit plot size	25 decimal			25 decimal	25 decimal	-
Seedling age (days)	30	-	-	28	-	-
Date of sowing/ transplanting	5-Aug-15	-	-	10-Aug-15	21-Nov-15	-
Date of harvesting	4-Nov-15	-	-	8-Nov-15	14-Feb-16	-
Field duration (days)	91	-	-	90	85	-
Turnaround time (days)	T.Aman-T.Aman: 275	-	-	T.Aman-Garden pea:13	Garden pea-T.Aman: 178	-
Yield (t ha^{-1})	3.83	-	-	4.10	6.65	-
Rice Equivalent yield (t ha^{-1})	3.83	-	-	4.10	9.98	-
Gross return (Tk. ha^{-1})	76600	-	-	281,600		-
Total variable cost (Tk. ha^{-1})	51911	-	-	89,284		-
Gross margin (Tk. ha^{-1})	24689	-	-	192,316		-
MBCR	5.49					

Price (Tk. kg^{-1}): Rice-20.00, Garden pea-30.00

Improvement of Wheat-Jute-T.Aman cropping pattern in level Barind tract

A field trial was conducted at the farmers' field of Joypurhat MLT Site during 2014-15 to improve Wheat-Jute-T.Aman cropping pattern. There were two treatments i.e, T_1: Existing cropping pattern: Wheat (BARI Gom-24)-Jute (Local/Indian)-T.Aman (Guti Sharna) and T_2: Alternate cropping pattern: Wheat (BARI Gom-26)-Jute (O-9897)-T.Aman (BRRI dhan49). Higher rice equivalent yield (17.20 t ha^{-1}) and gross margin (Tk. 201859 ha^{-1}) were obtained from alternate cropping pattern over existing cropping pattern due to introduction of new varieties.

Crop management practices, yield and economic return of existing and improved cropping Pattern at Joypurhat during 2014-15

Parameters	Existing Cropping Pattern			Improved Cropping Pattern		
Crop	Wheat	Jute	T.Aman	Wheat	Jute	T.Aman
Variety	BARI Gom-24	Indian	Guti sharna	BARI Gom-26	O-9897	BRRI dhan 49
Sowing date	15-20/11/14	7-11/4/15	8-15/8/15	15-20/11/14	7-11/4/15	11-15/8/15
Spacing	Broadcast	Continuous	Irregular planting	20 cm continuous	Continuous	20 cm × 15cm
Unit plot size	667 m^2			667 m^2		
Field duration	117	114	109	118	114	105
Turnaround time	8	10	7	7	12	8
Grain/Fibre Yield (t ha^{-1})	3.25	2.33	4.78	4.15	2.76	5.26
Harvesting date	16-21/3/15	28-30/7/15	20-21/11/15	15-21/3/15	28-31/7/15	17-20/11/15
Rice Equivalent Yield (t ha^{-1})	14.64			17.20		
Gross return (Tk. ha^{-1})	69308	127125	103840	87432	149861	115254
Total variable cost (Tk. ha^{-1})	39546	43182	44813	48487	55388	46813
Gross margin (Tk. ha^{-1})	29762	83943	59027	38945	94473	68441
Whole pattern Gross return (Tk. ha^{-1})	300273			352547		
Whole pattern Gross margin (Tk. ha^{-1})	172732			201859		
MBCR (Whole pattern)	2.26					

Market price of Wheat @ 20 Tkkg-^{1}, Straw @ 2.0 Tkkg-^{1}, Jute (Fibre) @ 50.0 Tkkg-^{1}, Stalk @ 5.0 Tkkg-^{1} and T.Aman @ 20.50 Tkkg-^{1}, Straw @ 1.5 Tkkg-^{1}

Development of Wheat-Jute-T.Aman rice cropping pattern against fallow-T.Aus-T.Aman rice cropping pattern in AEZ 22

An experiment was executed at multilocation testing (MLT) site Madhabpur, Habigonj during two consecutive years of 2013-14 and 2014-15 to observe the performance of improved cropping pattern and to increase the productivity and income of farmers. The existing and improved cropping patterns were Fallow-T.Aus-T.Aman (CP_1: Existing cropping patter) and Wheat-Jute-T.Aman rice (CP_2: Improvement cropping pattern), respectively. BARI Gom-26 of wheat, CVL-1 of Jute and Binadhan-7 of T.Aman rice were used in this trial. The CP_2 provided 13.74 t ha^{-1} of rice equivalent yield which was almost 88% higher than that of CP_1. Gross margin of CP_2 was Tk. 145868 ha^{-1}, whereas in CP_1 that was in Tk.69094 ha^{-1}.

Agro-economic performance of Wheat-Jute-T.Aman rice cropping pattern against Fallow-T.Aus-T.Aman rice at Madhobpur, 2013-15

Parameters		Existing cropping pattern (CP_1)			Improved cropping pattern (CP_2)		
		Fallow	T.Aus	T.Aman	Wheat	Jute	T.Aman rice
Variety		-	BR26	BRRI dhan33	BARI Gom-26	CVL-1	Binadhan-7
Date of sowing /Transplant		-	10-15 May 2013-14	12-15 Aug. 2013-14	20-25 Nov. 2013-15	4-7 Apr. 2014-15	5-10 Aug. 2014-15
Spacing		-	20cm×10cm	20cm×15cm	30cm in line sowing	20cm in line	20cm×15cm
Date of harvest			10-15 Aug. 2013-14	15-20 Nov. 2013-14	17-20 Mar. 2014-15	25-30 Jul. 2014-15	10-15 Nov. 2014-15
Field duration		-	85-90	95-100	98-105	100-108	90-95
Turnaround time (Days)		-	2-5	160-165	10-15	5-10	5-10
Yield (tha^{-1})	2013-14	-	3.92	3.75	3.83	2.31	4.13
	2014-15	-	3.85	3.64	3.61	2.26	3.88
	Average	-	3.89	3.70	3.72	2.29	4.01
Rice equivalent yield($tha^{-1}yr^{-1}$)		-	3.61	3.70	3.99+0.28	4.47+0.90	4.01
		-	7.31		13.74		
GR ($Tk.ha^{-1}$)		-	74005	75850	87535	110085	82205
TVC ($Tk.ha^{-1}$)		-	38341	42420	39624	51653	42680
GM ($Tk.ha^{-1}$)		-	35664	33430	47911	58432	39525
GM of whole pattern ($Tk.ha^{-1}$)		-	69094		145868		
MBCR (Whole pattern)		-	2.09				

Price of input & output ($Tk.kg^{-1}$): Urea-20.00, TSP-22.00, MoP-15.00, Poughing-TK.300 big^{-1}, Labour- Tk. 300 $m^{-1}d^{-1}$, wheat seed- 35.00, jute seed-75.00, wheat-22.00, straw-1.00, Fiber-40.00, Stick-5.00, Aus rice-19.00, Aman rice- 20.50 & straw-0.00

Development of cropping pattern Potato–Groundnut-T.Aman against Tobacco–Boro-T.Aman rice

The cropping pattern based experiment was conducted during 2014-15 to observe the performance of alternate cropping pattern Potato-Groundnut-T.Aman rice against existing cropping pattern Tobacco-Boro-T.Amon rice in the farmers field of Domer, Nilphamari and Maraihat, Sadar Upazila, Lalmonirhat. There were two treatments, T_1= Existing cropping pattern Tobacco–Boro-T.Aman rice, T_2= Alternate cropping pattern Potato-Groundnut-T.Aman rice. In Lalmonirhat sadar, gross margin (Tk. 220421 ha^{-1}) was higher in the alternate pattern compared to the existing cropping pattern (Tk. 90800 ha^{-1}). Similarly, in Domar, Nilphamari, gross margin (Tk. 225620 ha^{-1}) was higher in the alternate pattern compared to the existing pattern (Tk.86766 ha^{-1}).

Crop management practices, yield, cost and return anlysis of alternate and existing cropping pattern at Maraihat, Lalmonirhat.

Observation	Existing cropping pattern			Improved cropping pattern		
Crop	Tobacco	Boro	T.Aman	Potato	Groundnut	T.Aman
Variety	Motihar	BRRI dhan28	Swarna	Cardinal	BARI Chinabadam-8	BRRI dhan49
Spacing (cm^2)	50 ×50	20 ×50	20×15	60×25	30 ×15	20×15
Date of sowing/ transplanting	22-7/11/14	03-5/04/15	17-22/07/15	23-28/11/14	26-28/02/15	15-20/07/15
Harvesting date	28/2-2/03/2015	1-5/06/15	17-21/11/15	17-22/02/15	20-23/06/15	04-9/11/15
Variety	Motihar	BRRI dhan28	Swarna	Cardinal	BARI Chinabadam-8	BRRI dhan49
Field duration	110-120	95-100	110-115	86-90	114-120	105-110
Turnaround time	4	16	5	8	25	19
Grain or seed yield ($t\ ha^{-1}$)	Leaf 1.9 Stem0.8	4.90	4.55	26.1	2.32	4.10
Straw or stover yield ($t\ ha^{-1}$)	-	5.39	5.01	-	-	4.52
REY ($t\ ha^{-1}$)	6.09	5.15	4.85	15.82	6.68	4.38
Gross return ($Tk.\ ha^{-1}$)	100600	85015	80085	261000	110200	72248
Total variable cost ($Tk.\ ha^{-1}$)	69000	57500	48400	137337	42750	42940
Gross margin ($Tk.\ ha^{-1}$)	31600	27515	31685	123663	67450	29308
Whole pattern GM ($Tk.\ ha^{-1}$)	90800			220421		
MBCR (Whole pattern)	3.69					

Farmgate price ($Tk.\ kg^{-1}$): Rice=16.50; Straw=1.00; Potato=10.00; Groundnut=47.50; Tobacco leaf=50.00; Tobacco stem=7.00

Crop management practices, yield, cost and return anlysis of alternate and existing cropping pattern at the MLT site Domar, Nilphamari

Pattern	Existing cropping pattern			Improved cropping pattern		
Crop	Tobacco	Boro	T.Aman	Potato	Groundnut	T.Aman
Variety	Motihar	BRRI dhan28	Swarna	Cardinal	BARI Chinabadam 8	BRRI dhan 49
Spacing (cm^2)	50 ×50	20 ×50	20×15	60×25	30 ×15	20×15
Date of sowing/ transplanting	22-7/11/14	03-5/04/15	17-22/07/15	23-28/11/14	26-28/02/15	15-20/07/15
Harvesting date	28/2-2/03/2015	1-5/06/15	17-21/11/15	17-22/02/15	20-23/06/15	04-9/11/15
Field duration	110-120	95-100	110-115	86-90	114-120	105-110
Turnaround time	4	16	5	8	25	19
Grain or seed yield ($t\ ha^{-1}$)	Leaf 1.76 Stem0.8	4.80	4.45	24.95	2.28	4.69
Straw or stover yield ($t\ ha^{-1}$)		5.28	4.98	-	-	5.3
REY ($t\ ha^{-1}$)	5.67	5.12	4.75	15.12	6.91	5.01
Gross return ($Tk.\ ha^{-1}$)	93600	84480	78375	249500	114000	87450
Total variable cost ($Tk.\ ha^{-1}$)	66944	55787	46958	137840	44550	42940
Gross margin ($Tk.\ ha^{-1}$)	26656	28693	31417	111660	69450	44510
Whole pattern GM ($Tk.\ ha^{-1}$)	86766			225620		
MBCR (Whole pattern)	3.49					

Farmgate price ($Tk.\ kg^{-1}$): Rice=16.50; Straw=1.00; Potato=10.00; Groundnut=47.50; Tobacco leaf=50.00; Tobacco stem=7.00

Development of alternate cropping pattern Potato-Panikachu against Panikachu-T.Aman cropping pattern

A field trial was conducted at the farmers' field of Joypurhat MLT Site during 2014-15 to develop Potato-Panikachu cropping pattern against Panikachu-T.Aman cropping pattern. There were two treatments i.e, T_1: Existing cropping pattern: Panikachu (Local)-T.Aman (Guti sharna) and T_2: Altrnate cropping pattern: Potato (BARI Alu-25)-Panikachu (BARI Panikachu-2). Higher rice equivalent yield (40.22 t ha^{-1}) and gross margin (Tk. 552143 ha^{-1}) were obtained from alternate cropping pattern over existing cropping pattern due to introduction of new crops. The marginal benefit cost ratio was also higher from same treatment.

Crop management practices, yield and economic return of alternate cropping pattern Potato-Panikachu against existing cropping pattern Panikachu-T.Aman at Joypurhat during 2014-15

Parameters	Existing Cropping Pattern		Alternate Cropping Pattern	
Crop	T.Aman	Panikachu	Panikachu	Potato
Variety	Guti sharna	BARI Panikachu-2	BARI Panikachu-2	BARI Alu-25 (Asterix)
Sowing date	20-26/6/14	17-28/12/14	20-25/5/14	21-30/11/14
Spacing	20 cm × 15cm	60 cm × 25cm	60 cm × 45cm	60 cm × 25cm
Unit plot size	660 m^2		660 m^2	
Irrigation	-	14 times	2 times	2 times
Field duration	145	185	180	84
Turnaround time	5	30	95	05
Yield (t ha^{-1})	5.18	15.84 (stolon) 15.40 (rhizome)	16.68 (stolon) 15.90 (rhizome)	28.50
Straw yield (t ha^{-1})	5.93	-	-	-
Harvesting date	12-25/11/14	12/2-20/6/15	17/7-16/11/14	8-13/2/15
Rice equivalent yield (t ha^{-1})	24.07		40.22	
Total variable cost (Tk. ha^{-1})	49337	159646	149846	122710
Gross return (Tk.ha^{-1})	115085	378400	397200	427500
Gross margin (Tk.ha^{-1})	65748	218754	247353	304790
Whole pattern Gross return (Tk.ha^{-1})	493485		824700	
Whole pattern Gross margin (Tk.ha^{-1})	284502		552143	
MBCR (Whole pattern)	5.21			

Market price of Potato @ 15 Tkkg-^{1}, stolon @ 20.0 Tkkg-^{1}, Rhizome @ 4.0 Tkkg-^{1} and T.Aman @ 20.50 Tkkg-^{1}, Straw @ 1.50 Tkkg-^{1}

Development of Wheat-Mungbean-T.Aman cropping pattern against Fallow-Boro-T.Aman cropping pattern

The field experiment was conducted at Char Shreerampur village of Gouripur in Mymensingh during the Rabi season of 2014-15 to develop a diversified, economically profitable and environmentally sustainable cropping pattern against the existing one. The existing and alternate cropping pattern was as Fallow-Boro-T.Aman and Wheat-Mungbean-T.Aman, respectively. Wheat-Mungbean-T.Aman cropping pattern produced higher rice equivalent yield (15.99 t ha^{-1}), gross return (Tk. 239830 ha^{-1}), gross *margin (Tk. 93605 ha^{-1}) and MBCR (6.45) compared to Fallow-Boro-T.Aman cropping pattern.*

Yield and economic performances of Wheat-Mungbean-T.Aman and Fallow-Boro- T.Aman cropping pattern during 2014-15 & 2015-16

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T.Aman	Wheat	Mungbean	T.Aman
Variety	-	BRRI dhan28	BR11	BARI Gom-28	BARI Mung-6	BRRI dhan49
Grain yield (t ha^{-1})						
2014-15	-	5.29	3.98	4.01	0.98	4.10
REY (tha^{-1})	9.27			15.99		
Productivity increased (%)	-			73		
Gross return (Tk. ha^{-1})	139050			239830		
Total variable cost (Tk. ha^{-1})	130600			146225		
Gross margin (Tk. ha^{-1})	8450			93605		
MBCR	-			6.45		

* REY: Rice Equivalent Yield: Selling price: wheat = Tk.25/kg, Mungbean = Tk.80/kg, rice=15/kg

Development of alternate cropping pattern bitter gourd-mungbean-T.Aman against existing pattern bitter gourd-fallow-T.Aman at Phulbaria

The experiment was conducted at farmers' field of Phulbaria upazila under Mymensingh district during 2014-15 to develop an economically profitable cropping pattern and to increase intensification of cropping by using fallow land. The existing and improved cropping patterns were Bitter gourd-Fallow-T.Aman and Bitter gourd-Mungbean-T.Aman, respectively. The yield of bitter gourd (17.00 t ha^{-1}) was obtained from improved pattern over the existing one (14.28 t ha^{-1}) that was 19.05% higher over existing pattern. After inclusion of mungbean a promising yield 1100 kg ha^{-1} was obtained which resulted the rice equivalent yield 9.28 t ha^{-1}. The result revealed that alternate pattern was profitable than existing pattern.

Crop management practices, yield, cost and return analysis of existing and alternate cropping pattern during 2014-15.

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	Bitter gourd	Fallow	T.Aman	Bitter gourd	Mungbean	T.Aman
Variety	Tia	-	BRRI dhan49	Tia	BARI Mung-6	BRRI dhan62
Sowing time	15 January, 2014	-	August 07-15, 2015	15 January, 2014	15 May, 2014	August 03-10, 2015
Harvesting time	6 March-8 May, 2014	-	Dec 10-18, 2015	6 March-8 May, 2014	5 July, 2014	Nov 24-30, 2015
Yield (t ha^{-1})	14.28	-	3.50	17.00	1.10	4.10
REY (t ha^{-1})	-			9.28		
Gross return (Tk. ha^{-1})	273700			413100		
Variable cost (Tk. ha^{-1})	101700			129200		
Gross margin (Tk. ha^{-1})	172000			283900		
MBCR	5.06					

* REY: Rice Equivalent Yield, Selling price: T.Aman: 17 Tk kg^{-1}, Mungbean: 80 Tk kg^{-1}

Price of input and output: Urea: 16 Tk kg^{-1}, TSP: 22 Tk kg^{-1}, MOP: 15 Tk kg^{-1}, Gypsum: 10 Tk kg^{-1}, Zinc sulphate: 130 Tk kg^{-1}, Boric acid: 280 Tk kg^{-1}, Cowdung: 1 Tk kg^{-1}

Development of alternate cropping pattern through T.Aman- Mustard-Indian Spinach against T.Aman- Mustard-Fallow

The experiment was conducted at the MLT site, Dumuria, Khulna under AEZ-13 during 2015-`16 to develop an alternate cropping pattern (AP) against the farmers' existing one. The experiment was laid out in RCB design with six dispersed replications. The study was conducted using the improved cropping pattern (IP) T.Aman- Mustard-Indian spinach against the existing farmers cropping pattern (FP) T.Aman-Mustard-Fallow. AP gave highest Rice Equivalent Yield (REY) (28.99 t ha^{-1}) than FP (7.37 t ha^{-1}), which made highest gross return (Tk. 579,800 ha^{-1}), gross margin (Tk. 434,550 ha^{-1}) in IP. The MBCR of IP over FP was 5.10, which indicates high economic return in AP.

Agronomic management practices of the crops for the existing (T.Aman-Mustard-Fallow) and improved cropping patterns (T.Aman-Mustard-Indian Spinach) at the MLT site, Dumuria during 2015-16

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	T.Aman	Mustard	Fallow	T.Aman	Mustard	Indian Spinach
Variety	BR23	BARI Sarisha-14	-	Binadhan-7	BARI Sarisha-14	BARI Puishak-2
Spacing	20x20	Broadcast	-	20 x15	Broadcast	40 cm row
Unit plot size	25 decimal	25 decimal		25 decimal	25 decimal	25 decimal
Seedling age (days)	30-35	-	-	30-35	-	-
Date of sowing/ transplanting	1 August 2015	16 Nov. 2015	-	20 August 2015	24 Nov. 2015	3 March 2016
Date of harvesting	4 November 2015	12 February	-	18 November 2015	19 February 2016	15 May-15 June 2016
Field duration (days)	95	88	-	90	87	104
Turnaround time (days)	T.Aman-mustard:12	Mustard-T.Aman: 171	-	T.Aman-mustard:6	Mustard-Indian Spinach:13	Indian Spinach-T.Aman: 66
Grain/Vine Yield (t ha^{-1}) 2015-16	3.81	1.34	-	4.10	1.49	52.34
Straw Yield (t ha^{-1})	4.15	-	-	4.51	-	-
Rice equivalent yield (REY) (t ha^{-1})	4.02	3.35	-	4.32	3.73	20.94
Total REY (t ha^{-1})	7.37			28.99		
Gross return (Tk. ha^{-1})	147400			579800		
Variable cost (Tk. ha^{-1})	60525			145250		
Gross margin (Tk. ha^{-1})	86875			434550		
MBCR	5.10					

Unit Price (Tk. Kg^{-1}): Rice- 20, Rice straw- 1, Mustard- 50 and Indian Spinach: 8

Improvement of Wheat–D. Aus or T.Aus–T.Aman cropping pattern through intervention of short duration T.Aman variety

The experiment was conducted at the farmers' field during 2014-15 at Sadar, Bhola under AEZ-18 to observe the performance of improved cropping pattern against existing cropping pattern. There were two treatments viz., T_1= existing cropping pattern: Wheat-D.Aus or T.Aus (Local variety)-T.Aman (late variety) and T_2= improved cropping pattern: wheat-D.Aus or T.Aus (modern variety)-T.Aman (early variety). The improved cropping pattern gave higher rice equivalent yield (13.93 t ha^{-1}) than that of existing one (11.73 t ha^{-1}). Gross return (Tk. 22280 ha^{-1}) as well as gross margin (Tk. 108585 ha^{-1}) were higher in improved pattern over existing pattern.

Crop management, variety, yield, cost and return of existing cropping pattern and improved cropping pattern in Sadar, Bhola

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Wheat	T.Aus	T.Aman	Wheat	T.Aus	T.Aman
Variety	BARI Gom-26	Local (China irri)	BRRI dhan52	BARI Gom-26	BRRI dhan48	BRRI dhan33
Spacing	Broadcast	25 cm x 20 cm	25 cm x 20 cm	20 cm x continuous	25 cm x 15 cm	25 cm x 15 cm
Unit plot size	400 m^2	400 m^2	400 m^2	400 m^2	400 m^2	400 m^2
Sowing/Transplanting date	03.12.2014	25.04.2015	05.08.2014	20.11.2014	24.04.2015	05.08.2014
Harvesting date	30.03.2015	25.07.2015	28.11.2014	20.03.2015	28.07.2015	15.11.2014
Main field duration	118	90	116	120	96	103
Turn around time	26	10	4	29	7	10
Yield (t ha^{-1})	2.89	2.76	4.85	3.97	4.15	4.28
REY (t ha^{-1}) (T.Aman rice)	4.15	2.42	5.16	5.71	3.63	4.59
Pattern REY (t $ha^{-1}yr^{-1}$) (T.Aman rice)	11.73			13.93		
Gross return (Tk. ha^{-1})	66400	38720	82560	91360	58080	73440
Total variable cost (Tk. ha^{-1})	30285	30840	43690	32865	38650	42780
Gross margin (Tk. ha^{-1})	36115	7880	38870	58495	19430	30660
Whole pattern GR (Tk. ha^{-1})	187680			222880		
Whole pattern TVC (Tk. ha^{-1})	104815			114295		
Whole pattern GM (Tk. ha^{-1})	82865			108585		
MBCR over existing pattern	2.71					

Farm gate price of Wheat = Tk. 23 kg^{-1}, Local or BRRI dhan48 = Tk. 14 kg^{-1}, BRRI dhan52/ BRRI dhan33 = Tk.16 kg^{-1} Straw price of T.Aman rice = Tk. 5000 ha^{-1}

Improvement of Potato-Mungbean- T.Aman cropping pattern against Potato-Fallow- T.Aman rice

The experiment was executed at MLT site, Langrabazar, Muktagacha during 2014-15 and 2015-16 to develop an economically profitable cropping pattern and to increase intensification of cropping by using fallow land. The existing and improved cropping patterns were Potato- Fallow- T.Aman and Potato- Mungbean- T.Aman, respectively. In 2014-15, potato and mungbean yields 16.80 and 1.33 t ha^{-1}, respectively was in improved cropping pattern. In 2015-16, potato and mungbean were harvested and T.Aman in the field, hence first year results were included in this study. Potato equivalent yield (24.50 t ha^{-1}) calculated from improved cropping pattern. Gross margin (Tk. 267260 ha^{-1}) and MBCR (3.61) were also the highest in the improved cropping pattern.

Crop management information in farmer's existing cropping pattern and proposed improved cropping pattern at Langrabazar, Muktagacha during 2014-15

	Existing cropping pattern			Improved cropping pattern		
Crop	Potato	Fallow	T.Aman	Potato	Mungbean	T.Aman
Variety	Lal Pakkhri	-	BRRI dhan32	Lal Pakkhri	BARI Mung-6	BRRI dhan49
Spacing	20 cm×10 cm	-	20 cm×10 cm	20 cm×10 cm	30 cm× 10 cm	20 cm×10 cm
Sowing time	22 November, 2014	-	25-26 July, 2015	22 November, 2014	25 February, 2015	25-26 July, 2015
Harvesting time	19 Feburary, 2015	-	27-29 October, 2015	19 Feburary, 2015	30 April-13 May, 2015	27-28 October, 2015
Yield (t ha^{-1})	16.10	-	3.60	16.80	1.33	3.85
Potato equivalent yield (t ha^{-1})	17.02			24.50		
Productivity increased (%)	-			43.95		
Gross return Tk. ha^{-1})	310430			445200		
Total variable cost (Tk. ha^{-1})	140650			177940		
Gross margin (Tk. ha^{-1})	169780			267260		
MBCR	3.61					

Selling price: Potato = Tk.15/kg, Mungbean = Tk.90/kg

Improvement of existing cropping pattern Potato/Aroid (Mukhikachu)–T.Aman against Potato–Boro–T.Aman cropping pattern in the level barind tract of Rangpur region

A field trial was conducted in the farmers' field at MLT site, Khalashpir, Pirgonj, Rangpur during 2014-15 to evaluate the performance of Potato/Aroid-T.Aman against Potato-Boro-T.Aman rice for maximization of production and economic return. In improved pattern Meherpuri Mukhikachu cultivar was selected for alternate pattern. In case of potato higher yield (19.84 t ha^{-1}) was obtained from Asterix over Cardinal (19.65 t ha^{-1}). Aroid yield was recorded 14.20 t ha^{-1}, Boro rice yield was 4.21 t ha^{-1} and in T.Aman higher yield was obtained from BRRI dhan49 than Swarna. The gross margin was higher in improved pattern compared to existing pattern and it was mainly influenced by higher profit from aroid.

Details of the crop management of existing and improved cropping patterns at MLT site, Pirgonj, Rangpur

Pattern	Existing cropping pattern			Improved cropping pattern		
Crop	Potato	Boro	T.Aman	Potato	Aroid as relay	T.Aman
Variety	Cardinal	BRRI dhan28	BR11/ Swarna	Asterix	Meherpuri	BRRI dhan49
Spacing (cm^2)	60 ×25	20 × 15	20 ×15	60 ×25	60 × 20	20 ×15
Unit plot size	600 m^2			600 m^2		
Date of sowing/	01-4/12/14	02-05/03/15	25-28/07/15	26-8/11/14	10-15/01/15	20-22/07/15

Pattern	Existing cropping pattern			Improved cropping pattern		
Crop	Potato	Boro	T.Aman	Potato	Aroid as relay	T.Aman
transplanting						
Harvesting date	27-9/02/15	30/06/15	11-14/11/15	20-5/02/15	01-07/07/15	07-09/11/15
Field duration	88	120	109	86	174	111
Turnaround time	20	3	25	19	Relay	19
Grain or seed yield (t ha^{-1})	19.65	4.21	4.59	19.84	14.20	4.06
Straw or stover yield (t ha^{-1})		4.97	5.23			4.47
REY (t ha^{-1})	12.09	4.52	4.91	12.21	14.86	4.34
Gross return (Tk. ha^{-1})	196500	68120	74080	198400	241400	70525
Total variable cost (Tk. ha^{-1})	145362	56170	41950	145362	86280	42100
Gross margin (Tk. ha^{-1})	51138	11950	32130	53038	155120	28425
Whole pattern GM (Tk. ha^{-1})	95218			236583		
MBCR (Whole pattern)	5.67					

Price (Tk. kg^{-1}): Urea-, TSP-, MP-, Gypsum-, Zinc Sulphate-,Boric acid-, Rice grain-, 16.25, Rice straw-,1, REY: rice equivalent yield, MBCR: marginal benefit cost ratio, GM: gross margin, Potato=Tk.10kg^{-1}, Aroid= Tk.17 kg^{-1} Boro=Tk.16.25 kg^{-1}T.Aman rice=Tk.16.25 kg^{-1}

Development of alternate cropping pattern Potato-Bitter gourd + Pointed gourd) (as intercrop)-Onion (bulb) against Potato- Bitter gourd-T.Aman

An experiment was conducted at the MLT site Modhupur, Tangail during 2013-14 and 2014-15 under AEZ 9 to improve the productivity of existing cropping pattern by introducing new crops and crop varieties as well as higher yield and economic return of the farmers. Improved cropping pattern Potato + Bitter gourd + Pointed gourd - Onion was tested against the existing pattern Potato + Bitter gourd - T.Aman. The improved cropping pattern gave the higher gross margin (Tk.915085 ha $^{-1}$) compared to existing pattern (Tk.389290 ha^{-1}).

Crop management of alternate cropping pattern with Potato + Bitter gourd + Pointed gourd (as intercrop) – Onion (Bulb) and existing cropping pattern Potato + Bitter gourd - T.Aman at the MLT site, Modhupur, Tangail during 2013-14 & 2014-15

Parameters	Existing cropping pattern			Improved cropping pattern			
Crop	Potato	Bitter gourd	T.Aman	Potato	Bitter gourd	Pointed gourd	Onion
Variety	Diamant	Tia (lal teer)	*Pajam*	Diamant	Tia (lal teer)	BARI Potal-2	Local (Faridpuri)

Parameters	Existing cropping pattern			Improved cropping pattern			
Crop	Potato	Bitter gourd	T.Aman	Potato	Bitter gourd	Pointed gourd	Onion
Date of sowing/ Transplanting	26-11-13 to 1-12-13 & 16-11-14 to 21-11-14	30-11-13 to 4-12-13 & 27-11-14 to 11-12-14	28-7-14 to 3-8-14 & 25-7-15 to 3-8-15	23-11-13 to 29-11-13& 25-11-14 to 2-12-14	28-11-13 to 7-12-13 & 30-11-14 to 5-12-14	9-12-13 to 19-12-14 & 3-12-15 to 6-12-15	17-9-14 to 21-9-14 & 20-9-15 to 23-9-15
Seed rate (kg ha^{-1})	1500	6	50	1500	6	1600 vine	1200
Spacing	60 cm X 25	2.5 m X	20 cm ×	60 cm X 25	2.5 m X 2.5	2.5 m X	20 cm X 15 cm

Parameters	Existing cropping pattern			Improved cropping pattern			
Crop	Potato	Bitter gourd	T.Aman	Potato	Bitter gourd	Pointed gourd	Onion
	cm	2.5 m	20 cm	cm	m	2.5 m	
Date of harvesting (range)	27-2-14 to 5-3-14 & 16-2-15 to 21-2-15	9-4-14 to 7-6-14 & 19-4-15 to 28-5-15	10-11-14 to 18-11-14 & 12-11-15 to 18-11-15	26-2-14 to 30-2-14 & 23-2-15 to 29-2-15	9-4-14 to 3-6-14 & 28-3-15 to 10-6-15	20-5-14 to 14-9-14 & 15-5-15 to 16-9-15	15-11-14 to 19-11-14 & 22-11-15 to 27-11-15
Field duration (days) 2013-14	94+96=190		114	95+197=292			60
Field duration (days) 2014-15	93+98=191		110	90+199=289			63
Turnaround time (days) 2013-14	-	-	52	-	-	-	3
Turnaround time (days) 2014-15	5	-	59	13	-	-	6
Yield (t ha^{-1}) mean (2013-14 & 14-15)	23.46	21.62	3.22	25.63	23.24	24.03	19.17
Rice equivalent yield (t $ha^{-1}year^{-1}$) mean (2013-14 & 14-15)	17.82	20.98	3.22	18.89	26.63	29.33	12.78
Gross return (Tk. ha^{-1}) mean (2013-14 & 14-15)	259360	370560	59083	283330	399440	459325	235440
Total variable Cost (Tk. ha^{-1}) mean (2013-14 & 14-15)	128214	132348	39151	131443	135391	57396	138221
Meangross margin (Tk. ha^{-1}) mean	131146	238212	19931.5	151887	264050	401929	97220
Whole pattern means gross margin (Tk. ha^{-1})	389290			915085			
MBCR Whole pattern				4.23			

Unit price (Tk. kg^{-1}): Potato=10, Bitter gourd=14, Pointed gourd=22, Onion=14, *Aman* rice=15.00, Rice straw =2

Development of alternate cropping pattern through Mustard-Mungbean-T.Aman in coastal area of Khulna

A field experiment was conducted at the MLT site, Bagerhat, during 2015-`16 to improve the existing cropping pattern by introducing new crops and crop varieties for higher yield and economic returns of the farmers. The proposed cropping pattern Mustard-Mungbean-T.Aman was tested against the existing farmers' pattern T.Aman- Fallow-Fallow. Higher grain yield (4.40 t ha^{-1}) was obtained from Binadhan-7 compared to BRRI dhan-30 (3.22 t ha^{-1}). In improved pattern, the yield of mustard and mungbean were observed as 1.22 and 1.35 t ha^{-1}, respectively. The improved cropping pattern gave the higher gross margin (Tk.62338 ha^{-1}) compared to existing one (Tk. 24405 ha^{-1}).

Agronomic management practices of the crops for the existing and alternate cropping patterns at the MLT site, Bagerhat during 2015-‘16

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Fallow	Fallow	T.Aman	Mustard	Mungbean
Variety	BRRI dhan30	-	-	Binadhan-7	BARI Sarisha-14	BARI Mung-6
Spacing (cm^2)	20×20	-	-	20×15	Broadcast	Broadcast
Unit plot size	25 decimal	-	-	25 decimal	25 decimal	25 decimal
Seedling age (days)	40-45	-	-	27-30	-	-
Date of sowing/ transplanting	2 Aug 15-30 Aug 15	-	-	7 Aug 15- 18 Aug 15	22 Nov 15- 29 Nov 15	21 Feb 16-29 Feb 16
Date of harvesting	30 Aug 15 - 17 Dec 15	-	-	1 Nov 15- 10 Nov 15	10 Feb 16- 20 Feb 16	25.4.14-20.5.14
Field duration (days)	109-117	-	-	84-86	80-83	64-69
Turnaround time (days)	T.Aman-T.Aman: 249-257	-	-	T.Aman-mustard: 19-21	Mustard-mungbean: 9-11	Mungbean-T.Aman:99-114
Yield (t ha^{-1})	3.22	-	-	4.40	1.22	1.35
Equivalent yield (t ha^{-1})	3.22	-	-	4.40	3.39	3.75
Gross margin (Tk. ha^{-1})	24405	-	-	36943	26928	31000
Total variable cost (Tk. ha^{-1})	32120	-	-	40655	35410	36500
Gross return (Tk. ha^{-1})	56525	-	-	79200	61000	67500
Whole pattern gross margin (Tk. ha^{-1})	36130			207,700		

Price (Tk. kg^{-1}): T.Aman Rice sold-18.00, Rice straw-1.00, Mustard seed sold-50.00, Mustard straw-0.50, Mungbean seed-50.00

Development of alternate cropping pattern through Mustard-Jute-T.Aman in coastal area of Satkhira

The experiment was conducted at the MLT site, Satkhira during 2014-15 and 2015-16 to develop an improved cropping pattern (IP) against the farmers’ existing practice. The experiment was laid out in RCB design with four dispersed replications. The improved cropping pattern Mustard-Jute-T.Aman was investigated against the farmers existing cropping pattern T.Aman-Fallow-Fallow. The improved cropping pattern gave the higher gross margin (Tk. 98281 ha^{-1}) compared to existing cropping pattern (Tk. 21487Tk.t ha^{-1}).

Agronomic management practices of the crops for the existing and alternate cropping patterns at the MLT site, Satkhira during 2014-’15 and 2015-16

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Fallow	Fallow	T.Aman	Mustard	Jute
Variety	Local (*Jamai babu*)	-	-	Binadhan-7	BARI Sarisha-14	0-9897
Spacing	20x20	-	-	20 x15	Broadcast	Broadcast
Unit plot size	25 decimal			25 decimal	25 decimal	25 decimal

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Fallow	Fallow	T.Aman	Mustard	Jute
Seedling age (days)	30-35	-	-	30-35	-	-
Date of sowing/ transplanting	10.8.14 & 8.8.15	-	-	14.8.14-19.8.14 & 16.8.15-18.8.15	22.11.14 & 13.11.15-18.11.15	2.4.14-4.4.14 & 2.4.15-4.4.15
Date of harvesting	10.11.14&8.11.15	-	-	08.11.14-12.11.14 & 09.11.15-10.11.15	12.2.15 & 10.2.16-13.2.16	2.8.14 & 8.8.15-12.8.15
Field duration (days)	93 & 92	-	-	86 & 84-93	82 & 87-89	123 & 128-130
Turnaround time (days)	T.Aman-T.Aman: 272 & 273	-	-	T.Aman-mustard:12 & 5-8	Mustard-Jute:51 & 48-51	Jute-T.Aman:11 & 6-8
Yield (t ha^{-1}) 2014-15	3.95	-	-	4.70	2.01	2.15
Yield (t ha^{-1}) 2015-16	3.97	-	-	4.45	1.79	2.18
Rice equivalent yield (t $ha^{-1}yr^{-1}$) (average)	3.96			12.77		
GR (Tk. ha^{-1})	76550			241430		
TVC (Tk. ha^{-1})	55062			143148		
Gross margin (Tk. ha^{-1})	21487			98281		

Price (Tk. kg^{-1}):T.Aman rice seed -40.00, Rice sold-18.00, Rice straw-1.00, Mustard seed- 80.00, Mustard seed sold-50.00, Mustard straw-0.5, Jute seed-110.00, Jute sold-25.00, Jute stick-1.00

Development of alternate cropping pattern Mustard-Boro-T.Aman rice against Fallow-Boro-T.Aman

The trial was conducted at the MLT site, Bheramara, Kushtia during the year of 2013-14 and 2015-16 to improve the existing cropping pattern by inclusion of mustard and to increase crop yield and farmers income. The experiment was laid out in one ha of land under 5 farmers. Alternate cropping pattern Mustard (BARI Sarisha-14) - Boro (BRRI dhan28)- T.Aman (Binadhan-7) gave higher gross margin (Tk. 92001 ha^{-1}) against the existing pattern Fallow-Boro (BRRI dhan28)-T.Aman (BRRI dhan39) ((Tk. 69859 ha^{-1}).

Combined information about existing and alternate cropping patterns during 2013-16

Parameters	Existing Cropping Pattern			Alternate Cropping Pattern		
Crop	Fallow	Boro	T.Aman	Mustard	Boro	T.Aman
Variety	-	BRRI dhan28	BRRI dhan39	BARI Sarisha-14	BRRI dhan28	Binadhan- 7
Spacing (cm)	-	20 x15	20 x15	Broadcasting	20 x15	20 x15
Seedling age (days)	-	37-38	27-28	-	40-45	27-28
Sowing/Transplanting Sowing/transplanting date	-	01-05 1-5 1-1-5 February	07-10 7-10 7-10 August	08-15 8-15 8-15 November	06-10 6-10 6-10 February	22 July - 06 22 July – 6 August
Harvesting date	-	15-16 May	19-21 November	31 Jan.-08 February	10-16 May	28 Oct. – 13 Nov.
Field duration (seedling to seed)	-	100-105	102-107	84-85	94-98	99-102
Turnaround time (days)	-	Boro to T.Aman : 84-	T.Aman to Boro: 76	T.Aman to Mustard: 2-	Mustard to Boro: 2-5	Boro to T.Aman:74-

Parameters	Existing Cropping Pattern			Alternate Cropping Pattern		
Crop	Fallow	Boro	T.Aman	Mustard	Boro	T.Aman
		85		10		83
Yield (t ha^{-1})	-	5.73	4.22	1.15	5.49	4.92
Equivalent yield (t ha^{-1})	10.28			13.81		
Gross margin (Tk. ha^{-1})	-	37308	32551	19918	36913	35170
Total variable cost (Tk. ha^{-1})	-	68642	58036	35515	63745	55700
Gross return (Tk. ha^{-1})	-	105950	90587	55433	100657	90870
Whole pattern gross margin (Tk. ha^{-1})	69859			92001		

Development of alternate cropping pattern Potato-Mung bean-Fellow against Potato-Fallow-Fallow at Munshiganj

The experiment was conducted in the farmers' field at MLT site, Munshiganj during 2015-16 cropping season with potato based cropping pattern to test the agro-economic performance and to increase the cropping intensity and productivity. The predominant cropping pattern is Potato-Dhaincha-Fallow/Potato-Fallow-Fallow. BARI Mung-6 was included in the pattern instead of Dhaincha or fallow after harvesting of potato. The average yield of potato was 36.19 and 34.10 t ha^{-1}in the existing and improved pattern, respectively. Higher gross margin (Tk.88446 ha^{-1}) obtained from improved pattern than that of existing pattern (Tk.70427 ha^{-1}) with an MBCR of 1.7.

Agronomic management practices, yield and economic analysis of the existing and improved cropping pattern at Munshiganj during 2015-16.

Parameters	Existing cropping pattern			Improve cropping pattern		
Crop	Potato	Fallow	Fallow	Potato	Mungbean	Fallow
Variety	Diamant	--	--	Diamant	BARI Mung-6	--
Spacing (cm)	45 x 15	--	--	45x 15	Broadcast	--
Sowing time	Nov. 20, 2015	--	--	Nov. 20, 2015	March 10, 2016	--
Unit plot size (m)	10 x 10	--	--	10 x 10	10 x 10	
Harvesting time	3 March, 2016			3 March, 2016	20-30 May, 2016	
Field duration (day)	104-107	--	--	103-107	65-72	--
Yield (t ha^{-1})	36.19	--	--	34.10	1.06	--
Gross return (Tk. ha^{-1})	379995	--	--	358050	53300	--
Total variable cost (Tk. ha^{-1})	309568	--	--	283104	39800	--
Gross margin (Tk. ha^{-1})	70427	--	--	74946	13500	--
Whole pattern GR (Tk. ha^{-1})	379995			411350		
Whole pattern TVC (Tk. ha^{-1})	309568			322904		
Whole pattern GM (Tk. ha^{-1})	70427			88446		
MBCR	1.70					

Price of potato: Tk.10.50 kg^{-1} Price of mungbean: Tk.50.00 kg^{-1}

Conservation agricultural practices in Wheat-Mungbean-T.Aman rice cropping pattern

A field experiment was conducted at Shibpur, Puthia, Rajshahi during Rabi 2015-16 to study the effect of different tillage options implanted by BARI developed tillage machinery on the performance of wheat under CA practice in High Ganges River Floodplain soil. The seeds of variety BARI Gom-26 was sown with five tillage options i.e. strip tillage method, PTOS method, zero tillage method, bed planting method and conventional tillage method. The unit plot size was 6mx5m. Seeding was done with the help of BARI developed different tillage machinery. Seeds of BARI Gom 26 @ 120 kg ha^{-1} were sown on 22 November, 2015. Crop was harvested on 20 March, 2016. Among the tillage options, the PTOS tillage method showed better performance in respect of yield and economic return. All the tillage machinery exhibited better performance on wheat yield than conventional practice. The maximum grain yield (3.57 t ha^{-1}) was obtained from PTOS and the lowest (3.01 t ha^{-1}) from conventional practice. All the tillage machinery contributed to higher economic return by reducing cultivation cost over the conventional tillage system. Among the treatments, maximum gross margin (Tk. 37170 ha^{-1}) was obtained from PTOS.

Performance of short duration mustard varieties in between B.Aman and boro rice

The experiment was conducted at MLT site Manikganj during the *rabi* season of 2015-16 to verify the performance of short duration mustard varieties in between B. Aman and Boro rice. A total three short duration mustard varieties were tested in this experiment namely, BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17. The unit plot size was 5 Deci. The seeds were sown on 10-16 November after harvest of B.Aman rice. All the seeds were sown as broadcast. BARI Sarisha-14 and 17 were harvested on 30 January to 4 February, 2015, BARI Sarisha-15 on 6 to 9 February, 2015. The maximum days to maturity (85 days) was recorded in BARI Sarisha-15 and the minimum in BARI Sarisha -14 (80 days). The maximum no. of plants m^{-2} (109) was found in BARI Sarisha-15 which is statistically similar with BARI Sharisha-14 (88.83) and the minimum in BARI Sarisha 17 (68.33). Higher number of seeds $siliqua^{-1}$ was noted in BARI Sarisha-17 (29.90) which is statistically similar with BARI Sarisha-14 (27.97) and the lowest in BARI Sarisha-15 (21.87). The maximum 1000-seed weight was found in BARI Sarisha-17 (3.42 g) followed by BARI Sarisha-15 (3.40 g) and lowest in BARI Sarisha-14 (3.37 g). Maximum seed yield (1.48 t ha^{-1}) was obtained from the variety BARI Sarisha-17 followed by BARI Sarisha-14 (1.34 t ha^{-1}) and lowest in BARI Sarisha-15 (1.28 t ha^{-1}).

Development of Wheat-Mungbean-T.Aman cropping pattern against Wheat-Fallow-T.Aman cropping pattern

The experiment was conducted at farmers' field of Bhaluka, Mymensingh during 2014-15 to evaluate the agro-economic performance of improved and farmers' existing cropping pattern. Improved cropping patter (Wheat-Mungbean-T.Aman) and farmers' existing cropping pattern (Wheat-Fallow-T.Aman) were tested. The highest rice equivalent yield (15.08 tha^{-1}) was obtained from improved cropping pattern. Gross return of the improved pattern was Tk.257400 ha^{-1} which was 73% higher over farmers' pattern. The higher gross margin of the improved pattern was achieved mainly higher yield advantages of the component crops. The marginal benefit cost ratio (MBCR) was found 2.21 which indicated the superiority of the improved pattern and inclusion of mungbean in the existing pattern might be profitable and acceptable to the farmers.

Agronomic parameters of Wheat-Mungbean-T.Aman rice (IP) cropping pattern against farmers' existing pattern Wheat-Fallow-T.Aman rice (FP) at Bhaluka, Mymensingh during 2014-15

Parameters	Improved Pattern (IP)			Farmers' Pattern (FP)		
	Wheat	Mungbean	T.Aman	Wheat	Fallow	T.Aman
Variety	BARI Gom-26	BARI Mung-6	BRRI dhan57	BARI Gom-26	-	Local
Sowing/ transplanting time	26-29 Nov. 2014	02-10 April. 2015	08-10 Aug. 2015	4-7 Dec. 2015	-	10-15 Aug. 2015
Seed rate (kg ha^{-1})	120	35	40	120	-	45
planting method	Broad cast	Line	Line	Broad cast	-	Line
Spacing(Row×hill)	Continuous	Continuous	20cm×15cm	Continuous	-	20cm×15cm
Seedling age(day)	-	-	25-30	-	-	30-35
Pest control	IPM	IPM	IPM	-	-	Chemical
Harvesting time	15-17 March 2015	28 May-16 June 2015	24-27 October 2015	21-24 March 2015	-	15-20 Nov. 2015
Grain yield (t ha^{-1})	3.50	1.16	4.10	3.10	-	3.52
By-product yield (t ha^{-1})	3.65	1.76	4.40	3.29	-	4.20
TAT (days)	34	25	50	20	-	140
Field duration (days)	108	70	78	109	-	96
Rice-equivalent yield (tha^{-1}yr^{-1})	15.08			8.36		
Production efficiency (kgha^{-1}day^{-1})	34.22			32.29		
Land utilization index (%)	70.14			56.16		
Gross return (Tk ha^{-1})	257400			148800		
TVC (Tk ha^{-1})	136085			86920		
Gross margin (Tk ha^{-1})	121315			61880		
MBCR	2.21					

Development of Jute -T.Aman-Cucumber cropping pattern against farmers' existing pattern Jute -T.Aman-Fallow

The study was conducted at Bhaluka, Mymensingh during 2015 to determine the agro-economic performance of Cucumber-Jute-T.Aman through incorporation of modern high yielding varieties and improved management practices for crop production. Results showed that the improved management practices for the pattern provided higher yield in Jute and T.Aman rice. The gross return Tk. 287450 ha^{-1} and gross margin Tk. 115714 ha^{-1} of improved pattern were 77% and 152 % higher, respectively compared to that of farmers' pattern with only 48 % extra cost. The marginal benefit cost ratio, land utilization index and production efficiency indicated the superiority of the improved pattern over the farmers' practices.

Agronomic parameters of improved cropping pattern and farmers' existing pattern at Bhaluka, Mymensingh during 2015

Parameters	Improved Pattern (IP)			Farmers' Pattern (FP)	
	Cucumber	Jute	T.Aman	Jute	T.Aman
Variety	Naoga Green	CVL-1	BRRI dhan49	CVL-1	BRRI dhan32
Sowing/ transplanting	01-05 Jan. 2015	10-15 April 2015	10-15 Aug. 2015	01-05 April 2015	15-20 Aug. 2015
Seed rate (kg ha^{-1})	0.6	7	40	7	45
Planting method	Line	Broadcast	Line	Broadcast	Line
Spacing	75 cm×75cm	-	20cm×15cm	-	20cm×15cm

Parameters	Improved Pattern (IP)			Farmers' Pattern (FP)	
	Cucumber	Jute	T.Aman	Jute	T.Aman
(Row×hill)					
Seedling age (days)	-	-	25-30	-	30-40
Seedling hill^{-1} (No.)	2-3	-	2-3	-	3-4
Insect/ Rodent control	IPM	IPM	IPM	Chemical	Chemical
Harvesting time	2 Mar.-3 April 2015	25-31 July 2015	04-14 Nov. 2015	1-10 Aug. 2015	15-20 Nov. 2015
Fruit/Fibre/Grain Yield (t ha^{-1})	14.33	2.92	3.96	2.80	3.60
By-product (t ha^{-1})	-	4.37	4.48	4.12	4.00
TAT (days)	47	10	15	142	10
Field duration (days)	93	105	95	107	96
Rice-equivalent yield (t ha^{-1}yr^{-1})	16.61			8.85	
Production efficiency (kgha^{-1}day^{-1})	71.17			29.77	
Land utilization index (%)	82			59	
Gross return (Tk ha^{-1})	287450			161960	
TVC (Tk ha^{-1})	171736			116046	
Gross margin (Tk ha^{-1})	115714			45914	
MBCR	2.25				

Development of alternate cropping pattern T.Aman-Tomato-Jute in coastal area of Khulna

The experiment was conducted at the MLT site, Dumuria during 2014-`15 and 2015-16 to develop an improved cropping pattern against the farmers' existing one. The study was conducted using the improved cropping pattern T.Aman-Tomato-Jute and the existing cropping pattern T.Aman-Tomato-Fallow. The improved cropping pattern gave mean higher rice equivalent yield (44.68 t ha^{-1}) compared to farmers' existing pattern (36.10 t ha^{-1}) over two years. Mean higher gross margin (Tk. 658974 ha^{-1}) was also obtained from improved pattern compared to existing cropping pattern (Tk. 562942 ha^{-1}).

Agronomic management practices of the crops for the existing and alternate cropping patterns at the MLT site, Dumuria during 2014-'16

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Tomato	Fallow	T.Aman	Tomato	Jute
Variety	BR-11	Suraksha	-	Binadhan-7	BARI Tomato-14	0-72
Spacing	25x15	60x40	-	25 x15	60x40	Broadcast
Unit plot size	25 decimal			25 decimal	25 decimal	25 decimal
Seedling age (days)	33	30	-	28	30	-
Date of sowing/ transplanting	03.8.14 & 05.08.15	28.12.14 15.12.15	-	23-25.8.14 20.8.15	28.11.14-11.12.14 05.12.15	20.4.14 17.04.15
Date of harvesting	25.11.14 29.11.15	31.03.15 03.04.16	-	20-23.11.14 28.11.15	28.02.15 28.03.16	16.8.14 10.08.15
Field duration (days)	112 & 116	92 & 110	-	85 & 90	90 & 114	120 & 115
Ave, Turnaround time	T.Aman-	Tomato-	-	T.Aman-	Tomato-Jute: 35	Jute-

Parameters	Existing cropping pattern			Alternate cropping pattern		
Crop	T.Aman	Tomato	Fallow	T.Aman	Tomato	Jute
(days)	tomato: 24	T.Aman: 124		tomato: 15		T.Aman:9
Yield (t ha^{-1}) (2014-15) (2015-16)	3.50 3.57	58.00 59.23	-	3.95 4.01	68.00 67.50	2.22 2.19
Rice equivalent yield (t ha^{-1})	36.10			44.68		
Gross return (Tk. ha^{-1})	649800			804240		
Total variable cost (Tk. ha^{-1})	101012.5			145265.5		
Gross margin (Tk. ha^{-1})	562942.5			658974.53.49		
MBCR						

Intercropping of red amaranth, coriander and radish with pointed gourd

A field experiment was conducted at the MLT site Modhupur, Tangail during 2014-15 to improve the productivity of existing cropping pattern by intercropping and increase yield and economic return of farmers. Four treatment combinations viz. T_1= Pointed gourd + red amaranth, T_2= Pointed gourd + coriander (leaf), T_3= Pointed gourd + jute (leaf) and T_4= Sole Pointed gourd were considered. The unit plot size was 50 m^2. Pointed gourd (BARI Patal-2), red amaranth (BARI Lalshak-1), coriander leaf (local), jute leaf (local) were used as the experimental materials.

Sowing/ planting, harvesting date and fertilizer dose of pointed gourd and vegetables at MLT site, Modhupur, Tangail during 2014-15.

Crop	Sowing/ planting	Harvesting	Fertilizer dose (N-P-K-S-B) kg ha^{-1} & CD t ha^{-1}
Pointed gourd	25.10.14 to 24.11.15	2.4.15 to 29.11.15	230, 80, 250, 5, 1.5 & 15
Red amaranth	26.10.14 to 27.10.14	28.11.14 to 30.11.15	
Coriander (leaf)	26.10.14 to 7.2.15	25.11.14 to 18.3.15	
Jute (leaf)	7.2.15 to 8.3.15	23.3.15 to 16.4.15	

The highest pointed gourd equivalent yield 35.21 t ha^{-1} was recorded from the treatment T_2 (Pointed gourd + coriander leaf) and the lowest yield (25.49 t ha^{-1}) from the treatment T_4 (sole pointed gourd). The highest gross return (Tk. 598500 ha^{-1}) and gross margin (Tk. 381457 ha^{-1}) was obtained from the treatment T_2 (Pointed gourd + coriander leaf) and the lowest gross return (Tk. 433245 ha^{-1}) and gross margin (Tk. 217762 ha^{-1}) from the treatment T_1 (sole pointed gourd).

Intercropping of leafy vegetables with ash gourd

A field experiment was conducted at Shamgonj, Netrakona during *rabi* season of 2014-15 to find out the appropriate intercrop with ash gourd for higher productivity and maximum economic return. The experiment consisted of four crop combinations viz., ash gourd + red amaranth, ash gourd+ jute, ash gourd+ stem amaranth and sole ash gourd. The unit plot size was 4m × 2.5m and maintained the spacing for ash gourd 2m × 2 m. Thirty days old seedling of ash gourd (var. BARI Ash gourd-1), red amaranth (var. BARI Red Amaranth-1), jute (var. local) and stem amaranth (var. BARI Stem Amaranth-1) were sown on March 01, 2014 in the field. After attaining the recommended maturation the red amaranth, jute and stem amaranth were harvested on 35, 30 and 45 days after sowing respectively, harvest of ash gourd was started on May 05 and it continued up to July 02, 2015. Significantly the highest yield was obtained from sole ash gourd (34.11 t ha^{-1}). Among the intercrop, the highest ash gourd yield (30.65 t ha^{-1}) was obtained from ash gourd + jute which was close to ash gourd + red amaranth whereas the lowest (25.57 t ha^{-1}) in ash gourd + stem amaranth combination. By intercropping of ash gourd with different vegetables total productivity increased up to 6-16% higher over sole ash gourd due to the contribution of companion crops. The highest ash gourd equivalent yield (39.61 t ha^{-1}), gross return (Tk. 296880 ha^{-1}) and gross margin (Tk. 174433 ha^{-1}) were obtained from ash gourd + stem amaranth combination. Considering the experimental findings, ash gourd + stem amaranth might be suitable combination for higher productivity and economic return.

Intercropping of radish or carrot or garlic or onion with chilli

A field experiment on chilli based intercropping system was executed at Bhabkhali, Mymensingh during *rabi* season of 2015-16 to find out the appropriate intercrop cultivation with chilli for higher productivity and economic return. The experiment consisted of five crop combination viz., sole chilli, chilli + radish, chilli+ carrot, chilli + onion and chilli + garlic. Significantly the highest yield (green chilli) was obtained with sole chilli (11.62 t ha^{-1}). The unit plot size was 4 m x 2 m and spacing for chilli was 40 cm x 40 cm. Thirty days old seedlings of chilli (var. BARI Morich 1) and onion (var. BARI Piaz1) were planted in the field on 13 November, 2014. Seeds of radish (var. BARI Radish 4), carrot (var. New kuroda) and cloves of garlic (var. BARI Rasun 1) were sown on the same day. One row of radish, carrot, onion and garlic was planted/ sown in between two rows of chilli. Radish and carrot was harvested at 55and 90 days after sowing (DAS) while onion and garlic was harvested at 119 DAS, respectively. First harvest of green chilli was done at 109 days after planting (DAP) and continued up to 138 DAP. Among the intercropping treatments, the highest chilli yield (10.85 tha^{-1}) was obtained from chilli + garlic which was statistically idendical to the yield (10.67 t ha^{-1}) of chilli + onion whereas the lowest (8.65 tha^{-1}) in chilli + radish combination. Intercropping reduced 6 to 34 % chilli yield but total productivity increased by 81-148% over sole chilli due to the contribution of companion crops. The highest chilli equivalent yield (26.31 t ha^{-1}), gross return (Tk. 577400 ha^{-1}) and gross margin (TK. 436362 ha^{-1}) were obtained from chilli + garlic combination. Results revealed that chilli + garlic might be suitable combination for higher productivity and economic return.

Intercropping of red amaranth and coriander with cabbage

An experiment on intercropping of red amaranth and coriander with cabbage was conducted at the farmer's field of Trishal, Mymensingh during *rabi* season of 2015-16 to study the feasibility of intercropping of red amaranth and coriander with cabbage and to increase land use efficiency. Three intercropping combinations such as sole cabbage (100 %), cabbage (100 %) + red amaranth and cabbage (100 %) + coriander were evaluated. Results revealed that head yield of cabbage was adversely affected by intercropping but total productivity increased due to additional yield of red amaranth and coriander. The highest cabbage equivalent yield (84.85 tha^{-1}) was obtained from cabbage (100 %) + coriander treatment and the lowest cabbage equivalent yield (78.87 tha^{-1}) was recorded in sole cabbage cultivation. Gross return (TK 8,48,450 ha^{-1}) and gross margin (TK 6,16,150 ha^{-1}) was also highest in the same combination. Therefore, cabbage (100 %) + coriander might be suitable combination for higher productivity and economic return.

Intercropping of different short duration crops with sugarcane

A field experiment was conducted at MLT site Barura, Comilla during 2014-15 to find out suitable vegetable intercropping with sugarcane and also to estimate the profitability of intercropping with sugarcane at Comilla region. Results revealed that yield of sole sugarcane was 92.47 t ha^{-1} whereas for different crop combination with sugarcane such as sugarcane plus cabbage, sugarcane plus cauliflower, sugarcane plus potato, sugarcane plus garden pea and sugarcane plus garlic the adjusted sugarcane yield were 143.36, 122.90, 99.02, 97.19 and 125.15 t ha^{-1} respectively. Maximum gross return of TK. 1433600 ha^{-1} and net return of Tk. 683788 ha^{-1} came from sugarcane plus cabbage followed by sugarcane plus garlic, sugarcane plus cauliflower and sugarcane plus garden pea. On the other hand, for sole sugarcane gross return and net return were TK. 924700 and TK. 214388 ha^{-1}

respectively less than all intercropping combinations with sugarcane. From economic analysis it showed that highest benefit cost ratio (1.91) from sugarcane with cabbage combination and lowest from sole sugarcane (1.30).

Performance of intercropping of garden pea varieties with maize in the coastal area of Khulna

The experiment was conducted at the MLT site, Dumuria, Khulna during *rabi* season of 2014-15 and 2015-16 to find out the performance of garden pea varieties as intercrops with hybrid maize. Four treatment combinations were investigated as T_1: Sole maize (75cm x 25cm), T_2: Two rows of BARI Motorshuti-1 (30 cm apart) in between two rows of maize, T_3: Two rows of BARI Motorshuti-3 (30cm apart) in between two rows of maize, T_4: Two rows of local garden pea (30 cm apart) in between two rows of maize. The highest maize grain yield (8.42 t ha^{-1}) was recorded from $T_{1,}$ Sole maize and the highest maize equivalent yield (16.6 t ha^{-1}) was obtained from T_3 when BARI Motorshuti-3 was intercropped with maize, which gave the highest gross return (Tk. 249750 ha^{-1}) and gross margin (Tk. 184575 ha^{-1}).

Intercropping of groundnut with garlic in charland

An experiment was conducted at Tatrair Char, Ulipur, Kurigram and at Sariakandi, Bogra during the Rabi season of 2015-16 to observe performance of groundnut and garlic intercropping. The experimental design was RCBD with three replications. There were four treatments viz. T_1= Sole groundnut (100%), T_2= groundnut (100%) + garlic (75%) with 2 rows of garlic in-between groundnut rows, T_3= Two rows of garlic in alternate with one rows of groundnut and T_4= One rows of garlic in alternate with one rows of groundnut. The unit plot size was 8m×5m. The variety of groundnut was BARI Chinabadam-8 and garlic was BARI Rasun-1. Seeds of groundnut, garlic were sown/planted on 03 December, 2015 at Tatrair Char, Ulipur and 20-22 October, 2015 at Sariakandi, Bogra. The garlic and groundnut were harvested on 08 April and 03 May, 2016 at Tatrair Char, Ulipur, respectively, and that of Sariakandi were 17 March and 24 March, 2016, respectively. The highest groundnut equivalent yield was recorded from the treatment T_3 which was 5.87 t ha^{-1} at Ulipur, Kurigram and 7.54 t ha^{-1} at Sariakandi, Bogra. Consequently, the highest gross margin was found from the same treatment at both the locations.

Intercropping of groundnut with onion in charland

An experiment was conducted at Tatrair Char, Ulipur, Kurigram during the *rabi* season of 2015-16 to verify the performance of groundnut + onion intercropping in the farmers' field. There were four treatments viz. T_1= Sole Groundnut (100%), T_2= Groundnut (100%) + Onion (75%) & 2 rows garlic in-between groundnut rows, T_3= Two rows of onion in alternate with one rows of Groundnut and T_4= One rows of onion in alternate with one rows of groundnut. The unit plot size was 8m×5.cm. Spacing of groundnut was maintained 40 cm× 15 cm and onion 15 cm× 5cm. The variety of groundnut was BARI Chinabadam-8. Seeds of groundnut, onion was planted on 14 December during the season. The onion was harvested on 02 April 2016 and groundnuts were harvested on 04 May during year. Groundnut equivalent yields were recorded higher from all intercrop treatments as compared to sole groundnut production. The highest groundnut equivalent yield (3.90 t ha^{-1}) as well as gross margin (TK. 122070 ha^{-1}) was obtained from T_3 and the lowest groundnut equivalent yield (1.90 t ha^{-1}) as well as gross margin (Tk.19500 ha^{-1}) was obtained from T_1.

Performance of brinjal as intercrop with garlic and corriander

An experiment was conducted at MLT site, Shibpur, Puthia, Rajshahi during 2015-16 to the performance of garlic and coriander as intercrop with brinjal. Sole brinjal was grown as check. The unit plot size was 5m x 4m. Garlic cloves of BARI Rasun-2 @ 248 kg ha^{-1} and seeds of BARI Dhonia 1 @ 4 kg ha^{-1} were sown on 8 November, 2015 by maintaining 20cm x 10cm and 30 cm line to line with continuous seeding respectively. Locally popular variety of brinjal was planted at 20 DAS of garlic and coriander by keeping a distance of 60cm from line to line and 40cm frm plan to plant. Garlic was harvested on 29 February, 2016 and coriander on 18 march, 2016. Brinjal equivalent yield (BEY) was always higher under inter crop cultivation over sole brinjal. Maximum brinjal equivalent yield (36.91 t ha^{-1}) was observed in T_1: Brinjal+Garlic under intercrop cultivation followed by T_2: Brinjal+Coriander (22.5 t ha^{-1}) and the minimum in T_3: Sole brinjal (18.0 t ha^{-1}). Maximum gross return (TK. 369100 ha^{-1}) was recorded in T_1 followed by T_2 and the minimum (TK. 192300 ha^{-1}) from T_3 treatment.

Intercropping of garden pea with hybrid maize

The experiment was conducted at MLT site Jhikargacha, Jessore during the Rabi season of 2015-16. The experiment consisted of three treatments, viz., T1= Sole hybrid maize, T2= One row gardenpea between two rows of maize, T3= Two row gardenpea between two rows of maize. The treatments were tested in randomized complete block design with 3 replications. The unit plot size was 3m x 4m. The tested variety was BARI Hybrid Maize 9 and BARI Motorshuti 3. Seeds of maize and motorshuti were sown on 30 November 2015. Motorshuti was harvested on 09 February and maize on 19 April 2016The highest maize yield (7.26 tha^{-1}) was produced from sole maize and this was lowest (6.05tha^{-1}) from two rows garden pea intercropping between two rows of maize. The highest maize equivalent yield (18.14t ha^{-1}) was produced by two rows gardenpea between two rows of maize and the lowest (7.26t ha^{-1}) from sole maize. The highest gross margin (Tk. 131380 ha-1) was found from two row gardenpea between two rows of maize intercropping system. The lowest gross return (Tk. 37410 ha-1) was found from sole maize.

Intercropping onion and garlic with chilli in Bhola

A field trial was carried out at MLT site, Sadar, Bhola under AEZ-18 during *rabi* 2015-16 to evaluate the comparative performance of chilli+onion and chilli+garlic intercropping. Due to intercropping onion and garlic with chilli yield of chilli did not vary significantly. Both onion and garlic yield were very low due to late planting and insect attack in onion. The unit plot size was 8 m × 5 m. Spacing of chilli was 40 cm × 40 cm. Plant to plant distance of onion was 15 cm and garlic was 10 cm. Fertilizer rate was 82-47-34-1 kg ha^{-1} N-P-K-Zn for sole chilli. Though chilli yield did not differ significantly, but the cumulative effect of chilli and onion or garlic yield made difference in chilli equivalent yield. Two rows onion with chilli gave the highest chilli equivalent yield which was statistically identical to that of two rows garlic with chilli. Sole chilli produced the lowest chilli yield.

Intercropping of coriander and garlic with radish

A field experiment on radish based intercropping system was conducted at Shamgonj under Netrakona district of Bangladesh during winter season of 2015-16 to find out the appropriate intercrop with radish for higher productivity and economic return. The experiment consisted of four crop combinations viz., radish sole, radish + coriander, radish + garlic and radish + coriander + garlic. Significantly the highest yield was obtained from sole radish (44.58 t ha^{-1}). Among the intercrop, the highest radish yield (41.72 t ha^{-1}) was obtained from radish +coriander which was close to radish +garlic (40.72 t ha^{-1}). The lowest (38.36 t ha^{-1}) was found in radish + coriander + garlic combination. By intercropping of radish with different vegetables total productivity increased up to 6-23% over radish due to the contribution of companion crops. The highest radish equivalent yield (55.22 t ha^{-1}), gross return (Tk. 552200 ha^{-1}) and gross margin (Tk. 484554 ha^{-1}) were obtained from radish + coriander + garlic combination. Considering the experimental findings, radish + coriander + garlic might be suitable intercrop combination for higher productivity and economic return.

Intercropping of coriander with garlic at charland ecosystem

A field experiment on intercropping of coriander with garlic was conducted at char land of Kalirbazar in Mymensingh during *rabi* season of 2015-16 to evaluate the performance of garlic production in intercropping system and to increase land use efficiency. Three treatments viz., garlic (100%) + Coriander (1 time cultivation), garlic (100%) + Coriander (2 times cultivation) and Sole garlic (100%) were considered. The experiment was laid out in randomized complete block design with three replications. Intercropping reduced garlic yield 8-17% but productivity increased by 7.24-11.33% due to additional yield of coriander leaf. The highest garlic equivalent yield (7.06 t ha^{-1}), gross return (Tk. 5,79,800 ha^{-1}) and gross margin (Tk. 4,19,318 ha^{-1}) were obtained from garlic (100%) + Coriander (2 times cultivation) . Therefore, garlic (100%) + Coriander (2 times cultivation) might be suitable combination for higher productivity and economic return.

Intercropping of onion and garlic with chilli at charland

A field experiment was executed at Char Shreerampur village of Gouripur under Mymensingh district during *rabi* season of 2015-16 to find out the appropriate planting ratio of onion and garlic as intercrop with chilli for higher productivity and economic return. The experiment was consisted with seven treatments such as chilli (100%) + onion (25%), chilli (100%) + onion (50%), chilli (100%) + garlic (25%), chilli (100%) + garlic (50%), sole chilli, sole onion and sole garlic following randomized complete block design with 3 dispersed replications. Iintercropping onion and garlic did not affect chilli yield moreover, it increased system productivity by 31-116% over sole chilli. All the intercropping combinations were performed better over sole crops in terms of chilli equivalent yield (CEY), land equivalent ratio (LER) and economic point of view. However, the highest CEY (33.63 t ha^{-1}), LER (1.52), gross return (Tk. 672613 ha^{-1}) and gross margin (Tk. 550576 ha^{-1}) were obtained from chilli (100%) + garlic (50%) combination. Results revealed that this combination (chilli 100% + garlic 50%) might be suitable for higher productivity and economic return of the selected area.

Intercropping of leafy vegetables with sweet gourd at charland

A field experiment was conducted at char land of Dori Bhabkhali, Mymensingh during Rabi season of 2015-16 to select suitable leafy vegetables intercropping with sweet gourd for higher productivity and economic return. Six crop combinations viz., sweet gourd + Red amaranth, sweet gourd + Coriander leaf, sweet gourd + Radish leaf, sweet gourd + mustard leaf, sweet gourd + spinach and sole sweet gourd were investigated following randomized complete block design with 3 dispersed replications. Intercropping leafy vegetables did not reduce sweet gourd yield moreover, it increased system productivity (expressed as sweet gourd equivalent yield) by 25-74% over sole sweet gourd. All the intercropping combinations were performed better in terms of sweet gourd equivalent yield, gross return and gross margin over sole crops. However, the highest sweet gourd equivalent yield (50.95 t ha^{-1}), gross return (Tk. 509538 ha^{-1}) and gross margin (Tk. 403828 ha^{-1}) were obtained from sweet gourd + spinach combination. Results revealed that sweet gourd + spinach might be suitable combination for higher productivity and economic return in charland of Mymensingh.

Intercropping of garlic with groundnut

A field experiment was conducted at Jharbari, Birgonj, Dinajpur to improve the productivity of groundnut by intercropping with garlic for higher yield and economic return. Three treatment combinations viz. T_1= Sole groundnut (40cm × 15cm), T_2= Groundnut + 1 row garlic (15cm × 5cm) and T_3= Groundnut + 2 rows garlic (15cm × 5cm) were considered. The unit plot size was 6 m × 5 m. Groundnut (BARI Chnabanam-8) and garlic (BARI Rasun-2) were used as planting materials. The groundnut and garlic was sown on November 15, 2015. The garlic was harvested on 5 April, 2016 and groundnut harvested on 25 April, 2016. The highest groundnut equivalent yield was recorded from groundnut + 2 rows garlic and the lowest in sole groundnut. The highest gross return and gross margin were obtained from the treatment groundnut + 2 rows garlic and the lowest in sole groundnut.

Intercropping garlic with chilli in the haor area of Kishoreganj

The study was conducted at Nikli, MLT's under OFRD Kishoreganj during Rabi season of 2014-15 and 2015-16 to observe the performance of garlic as intercrop with chilli. Four treatments like sole chilli, chilli with one row garlic, chilli with two rows garlic and broadcasting chilli with garlic were used in this study. The used chilli variety was Balujhuri as local popular variety. The unit plot size was 6 m x 3 m. The chilli seedlings were sown with 30 cm × 25cm spacing and garlic was 10 × 10 cm on 24 October 2014 and 05 November 2015 respectively. The garlic variety was BARI Rasun-3. The chilli was harvested, 5 January to 12 March 2015, and garlic was 12 March 2015 where as the chilli was harvested 14 March 2016 and garlic 23 March 2016. The highest green chilli yield 15.77 and 13.91 t ha^{-1} was found in sole in 2014-15 and 2015-16 growing season, respectively. One row garlic with chilli gave maximum yield (3.53 t ha^{-1}) which reflected on the highest equivalent chilli yield (25.49 t ha^{-1} and the lowest 13.91 t ha^{-1} in sole chilli. The highest gross return (Tk.356860 ha^{-1}) and MBCR (2.78) was also found in one row garlic with chilli and the lowest MBCR (1.57) in broadcasting garlic with chilli combination.

Intercropping cropping chickpea with foxtail millet in different plant population under rainfed condition in high Barind Tract

In order to study the effect of chickpea (BARI Chola-9) and Foxtail Millet (BARI Kaon-1) intercropping in different plant population, an experiment was conducted at Chabbishnagar, Godagari, Rajshahi during 2015-16 cropping season. In this experiment, chickpea and foxtail millet were intercropped using additive pattern. In this study, the main plots were pure stand of two crops as well as three intercropping ratios (100% chickpea + 20% foxtail millet, 100% chickpea + 40% foxtail millet, 100% chickpea + 60% foxtail millet). The unit plot size was 5 m x 6 m. The variety of chickpea and foxtail millet were BARI Chola-9 and BARI Kaon-1, respectively. Seeds of both crops were sown on 26 October 2015 simultaneously. The crops were harvested on 06 March, 2016. Intercropping of chickpea and kaon controlled weeds, and sole chickpea gave the superior yield (1.48 t ha^{-1}) in compared to other intercropped treatments. The maximum gross return and gross margin were also recorded in the sole chickpea that was followed by intercropping seeding ratio of 100% chickpea + 20% foxtail millet.

Effect of planting method on mustard-boro as mixed cropping system

A field experiment was carried out at Multi Location Testing (MLT) site, Debiwder and Chandpur during the cropping season 2015-16 to find out the suitable rice planting method and to calculate the cost and return of mixed cropping system in Comilla region. The treatment combinations used for the experiment were T_1= Boro rice (broadcasting) + Mustard, T_2= Boro rice (Line sowing) + Mustard, T_3= Sole mustard, T_4= Sole boro rice. According to the treatments, seeds of mustard (BARI Sarisha-14) and Boro rice (BRRI dhan58) were broadcasted and line sown on 09-11 November, 2015 @ 8 and 40 kg ha^{-1}, respectively. The unit plot size was 100 m^2. Mustard was harvested on 04-06 February, 2016, whereas boro rice on 24-26 April, 2016. Results revealed that all the mixed cropping combinations showed superior in terms of gross return, gross margin and rice equivalent yield (REY) than sole cropping. The highest rice equivalent yield (8.52 t ha^{-1}) was found in the treatment combination of boro rice line sowing + mustard. The combination of boro rice line sowing with mustard (T_2) gave the highest gross return (TK. 127800 ha^{-1}) and gross margin (TK.77400 ha^{-1}) where sole crop of mustard (T_3) gave the lowest gross return (TK. 6512 ha^{-1}) and gross margin (TK. 21450 ha^{-1}) which indicated the advantage of mixed cropping over the sole cropping.

Mixed cropping of mungbean and cowpea in Bhola

A field trial was carried out at MLT site, Daulatkhan and Bhola sadar under AEZ-18 during *rabi* season of 2014-15 and 2015-16 to evaluate the comparative performance of mungbean and cowpea mixed cropping in different ratio. The treatments were sole mungbean, 90% mungbean+10% cowpea, 75% mungbean+25% cowpea and 50% mungbean+50% cowpea. The experiment was set up at 22 January, 2016 and 20-24 January in 2015. Crop was cultivated as rainfed. Mungbean was harvested at 67 and 88 days after sowing (DAS). Cowpea was harvested at 82 and 115 DAS. In 2015-16 mixed cropping: 90% mungbean+10% cowpea gave the highest mungbean equivalent yield (1380 kg ha^{-1}). Increasing cowpea seed rate decreased mungbean equivalent yield gradually. The highest gross return (Tk. 75900 ha^{-1}) and gross margin (Tk. 45380 ha^{-1}) was obtained from 90% mungbean + 10% cowpea mixed system. Similar trend was observed in 2014-15.

Mixed cropping of lentil and mustard under rainfed condition in high Barind Tract

The experiment was undertaken to study the effect of lentil (BARI Masur-6) and mustard (BARI Sarisa-15) mixed cropping in different plant population at Kadamshahar, Godagari, Rajshahi during 2015-16 cropping season. In this study, the main plots were pure stand of two crops as well as three mixed cropping ratios (100% lentil + 10% mustard, 100% lentil + 20% mustard, 100% lentil + 30% mustard). The unit plot size was 10 m x 4 m. The variety of lentil and mustard were BARI Masur-6 and BARI Sarisa-15, respectively. Seeds of both crops were sown on 26 October, 2015 simultaneously. The fertilizer doses were 90-27-48-10-1-0.3 N-P-K-S-Zn-B, receptively. The mustard crop was harvested on 15 January 2016 and lentil was harvested on 05 February. Mixed cropping of lentil and mustard (T_3= 100% lentil + 10% mustard) gave the superior yield (1.19 t ha^{-1}) in compared to sole lentil and other mixed cropped treatment. The maximum gross return and gross margin were also recorded in the T_3(100% lentil + 10% mustard) that was followed by sole lentil T_1 (100% lentil).

Mixed cropping of lentil with cowpea

The field experiment was carried out at South Lemua, MLT site, Feni (AEZ 19) during Rabi season of 2015-16 to verify the performance of Lentil as mixed crop with Cowpea. The treatment combinations used for the experiment were T_1= Sole lentil (100 %) @ seed rate 40 kg ha^{-1}, T_2 =Sole cowpea (100%)@ seed rate 45 kg ha^{-1}, T_3 = Lentil (100%) + cowpea (10%), T_4 = Lentil (100%) + cowpea (20%) and T_5 = Lentil (100 %) + cowpea (30 %). Lentil variety BARI Mashur-6 and cowpea variety BARI Felon-1 were used in this study. The unit plot size was 40 m^2(10m x 4m). Seeds of Lentil (BARI Mashur-6) and Cowpea (BARI Felon-1) were broadcasted on 7 -11 December, 2015. Lentil was harvested on 10-12 March, 2016 whereas Cowpea harvesting started on 8 March and continued up to 13 April, 2016. The yield of Lentil decreased with the increase of cowpea population in the mixed cropped situation. All the mixed cropping combinations showed superiority in terms of gross return, gross margin and lentil equivalent yield (LEY) than sole cropping. The highest lentil equivalent yield (1438 kg ha^{-1}) was found in the treatment combination of lentil (100%) + cowpea (20%) and it was observed that the combination of lentil (100%) + cowpea (20%) (T_4) gave the highest gross return (Tk. 115050 ha^{-1}) and gross margin (Tk. 90900 ha^{-1}). The sole crop of cowpea (T_2) gave lowest gross return (Tk. 43300 ha^{-1}) and gross margin (Tk. 20550 ha^{-1}).

Mixed cropping of field pea with mustard

The field experiment was carried out at South Lemua, MLT site, Feni (AEZ 19) during Rabi season of 2015-16 to verify the performance of Field pea mixed crop with Mustard. The treatment combinations used for the experiment were T_1 = Sole Field pea (100 %) @ seed rate 50 Kg ha^{-1}, T_2 =Sole Mustard (100%) @ seed rate 10 Kg ha^{-1}, T_3 = Field pea (90%) + Mustard (10 %), T_4 = Field pea (80 %) + Mustard (20 %) and T_5 = Field pea (70 %) + Mustard (30%). Field pea variety (BARI Motor-1) and Mustard variety (BARI Sarisha-14) were used in this study. The unit plot size was 40 m^2 (10m x 4m). Seeds of field pea (BARI Motor-1) and mustard (BARI Sarisha-14) were broadcasted on 7 to 11 December, 2015. Mustard was harvested on 22-28 February 2016, whereas Field pea on 20 March-25 March, 2016. The yield of Field pea decreased with the increase of Mustard population and the yield of Mustard decreased with the increase of Field pea population in the mixed cropped situation. All the mixed cropping combinations showed superiority in terms of gross return, gross margin and Lentil equivalent yield (LEY) than sole cropping. The highest Field pea equivalent yield (1822 kg ha^{-1}) was found in the treatment combination of Field pea (80 %) + Mustard (20 %) and it gave the highest gross return (Tk. 91070 ha^{-1}) and gross margin (Tk. 67130 ha^{-1}). The sole crop of Mustard (T_2) gave the lowest gross return (Tk. 66300 ha^{-1}) and gross margin (Tk.44025 ha^{-1}).

Performance of different cucurbits as relay crop with potato

An experiment was conducted at MLT site, Shibpur, Puthia, Rajshahi during 2015-16 to see the performance of different cucurbits. The experiment consisted of four treatments viz. T_1: Bottle gourd/Potato, T_2: Sweet gourd/Potato, T_3: Khira/Potato and T_4: Sole potato. The unit plot size was 8m x 3m. Potato tubers of BARI Alu 46 @ t ha^{-1} were planted on 5 November, 2015 by maintaining 60 cm line to line and 20 cm tuber to tuber distance. Locally popular varieties of cucurbits were planted at 55 DAS of potato by keeping a distance of 2m from pit to pit. Potato was harvested on 6 february, 2016. Potato equivalent yield (PEY) was always higher under mixed crop cultivation over sole potato. Maximum potato equivalent yield (45.77 t ha^{-1}) was observed in T_1: Potato/Bottle gourd under mixed crop cultivation followed by T_2: Potato/Sweet gourd (45.57 t ha^{-1}) and T_3: Potato/Khira (38.52 t ha^{-1}). Maximum gross return (Tk. 457700 ha^{-1}) was recorded in T_1 which was very close to T_2 and the minimum (Tk. 334500 ha^{-1}) from T_4 treatment.

Performance of wheat varieties relaying with T.Aman rice under wheat–T.Aus-T.Aman cropping pattern

The trial was conducted at the MLT site Kushtia during the year of 2015-16 to select the suitable wheat variety for relay condition and to increase production and farmers' income. The experiment was laid out in RCB design with six replications. Wheat var. BARI Gom-24, BARI Gom-26, BARI Gom-27 and BARI Gom-28 were used in the trial. Unit plot size was 10 m × 15 m and the replications were six. The varieties of wheat were BARI Gom-24, BARI Gom-26, BARI Gom-27 and BARI Gom-28. Seeds of wheat varieties were sown as relay in T.Aman field on 18 November, 2015. The harvesting time of T.Aman was 22-24 November, 2015. Results revealed that the yield of BARI Gom-28 was the highest among all other varieties. The gross return and gross margin of BARI Gom-28 was also the highest in all other varieties.

Relay cropping of garden pea with T.aman rice in Fallow- Boro-T.Aman rice cropping pattern

The experiment was executed at Muktagacha MLT site during 2014-15 and 2015-16 to develop an economically profitable cropping pattern and to increase intensification of cropping by using fallow land before boro cultivation. The existing and improved cropping patterns were T.Aman-Fallow- Boro and T.aman/Garden pea-Boro rice. The experiment has six dispersed replications and the unit plot size was 10m × 10m. The experiment was initiated with T.Aman as the first crop and Garden pea as relay crop which was sown 15 days before T.Aman harvest. In the year 2014-15, garden pea yield was recorded 3.61 t ha^{-1}. In 2015-16, garden pea yield were recorded as 3.96 t ha^{-1} in the improved cropping pattern. In the existing cropping pattern, T.Aman rice yield 3.30 t ha^{-1} was recorded for the same period of time. Average rice equivalent yield (17.42 tha^{-1}) was maximum in improved cropping pattern. Average gross margin (TK. 1,23,700 ha-1) was also highest in the improved cropping pattern and MBCR was 3.72.

Influenced of mulching and tillage on soil moisture conservation and yield of tomato in high Barind Tract

The study was conducted at FSRD site, Kadamshahar, Godagari, Rajshahi during the Rabi season of 2015-16 to find out suitable tillage practice and mulching for conserving residual soil moisture for tomato cultivation in High Barind Tract. There are two tillage methods viz., T_1= Minimum tillage (one ploughing) and T_2= Conventional tillage (four ploughing); and three mulching practices viz. M_1= No mulch, M_2= Rice straw mulch @ 3 t ha^{-1} and M_3= Rice straw mulch @ 5 t ha^{-1}. The experiment was laid out in split plot design with six dispersed replications. Interaction effect of tillage and mulching were found significant on soil moisture and also on tomato yield. Minimum tillage along with straw mulch at the rate of 5 t ha^{-1} conserved more soil moisture than the other treatments. Consequently, this treatment combination also produced significantly higher tomato yield (53.67 t ha^{-1}) and gave higher economic benefit among all other treatments. The results indicated that minimum tillage (one ploughing) coupled with straw mulch at the rate of 5 t ha^{-1} might be a good option for better soil moisture conservation and higher economic benefit and yield of tomato in High Barind Tract of Bangladesh.

Establishment of relay lentil with t.aman rice as influenced by stubble height in high Barind Tract

The experiment was carried out at FSRD site, Kadamshahar, Godagari, Rajshahi during the Rabi season of 2015-16 to find out the optimum height of rice stubble and the suitable time for successful relay lentil production with T.Aman rice in High Barind Tract. The treatments comprised of three different stubble height viz., 20SH: 20 cm stubble height, 30SH: 30 cm stubble height and 40SH: 40 cm stubble height; and four different sowing times viz., S_1: Sowing at 20 days before harvest of T.Aman rice, S_2: Sowing at 15 days before harvest of T.Aman rice, S_3: Sowing at 10 days before harvest of T.Aman rice and S_4: Sowing at harvesting date of T.Aman rice. The trial was laid out in split plot design with six dispersed replications. Stubble height treatments were assigned in the main plots and sowing time treatments in the sub-plots. It was observed that 20 cm stubble height and sowing of lentil at 15 days before harvest of T.Aman rice conserve more residual soil moisture than other stubble height and sowing time. Stubble height at 20 cm gave significantly higher seed yield (836 kg ha^{-1}) than all other treatments. Significantly maximum seed yield (932 kg ha^{-1}) of lentil was obtained from plot sown at 15 days before harvest of T.Aman rice and minimum at sowing on just after harvest of T.Aman rice. The maximum seed yield was recorded from the treatment combination of 20 cm stubble height and 15 days before harvest of T.Aman rice (998 kg ha^{-1}). Results revealed that sowing at 15 days before harvest of T.Aman rice accompanied by 20 cm stubble height was found the most satisfactory and economically profitable method for lentil cultivation under rainfed condition in High Barind Tract (HBT) of Bangladesh.

Effect of sowing dates on yield of soybean in high barind tract

The trial was conducted at the FSRD site Kadamshahar, Godagari, Rajshahi during the Rabi season of 2015-16 to find out the suitable sowing date for soybean cultivation under rainfed condition in High Barind Tract. Soybean var. BARI Soybean-5 was sown on three sowing dates: T_1 (1 Dec), T_2 (10 Dec) and T_3 (20 Dec. The treatment T_1 (1 Dec) produced the highest seed yield (1.27 t ha^{-1}) and T_3 (20 Dec) gave the lowest one (0.98 t ha^{-1}). It can be concluded that soybean should be sown by 1 December in High Barind Tract.

Effect of sowing dates and varieties on yield of mustard

The experiment was conducted at the Agricultural Research Station, Rajbari, Dinajpur during the *rabi* season of 2015-16 to determine the optimum sowing date for maximizing the yield of mustard with three varieties of mustard (BARI Sarisha-14, BARI Sarisha-15 and Tori-7) under five dates of sowing viz., 21 October, 01 November, 10 November, 20 November and 30 November when the crop faced high temperature. The highest seed yield (1.57 t ha^{-1}) was recorded from BARI Sarisha-15 at 21 October sowing which was identical to BARI Sarisha-14. The variety BARI Sarisha-14 and BARI Sarisha-15 also gave satisfactory seed yield up to 20 November sowing. The lowest seed yield was obtained from Tori-7 regardless of sowing time.

Effect of different tillage system for wheat cultivation

An experiment was conducted at two MLT sites, Bhuapur and Mirzapur, Tangail during *rabi* season of 2015-16 to select the suitable tillage system/cultural practice for wheat cultivation and to increase yield and economic return of farmers. Two treatments viz. T_1: Seed sown by PTOS (Power tiller operated seeder) and T_2: Farmers' practice were considered. The higher grain yield (3.62 and 3.82 t ha^{-1}) were obtained from T_1 (Seed sown by PTOS) and the lower grain yield (3.34 and 3.65 t ha^{-1}) were obtained from T_2 (Farmers' practice) at both the locations. Higher gross margin (Tk. 39805 and 40850 ha^{-1}) was obtained from T_1 and the lower (Tk. 28650 and 32455 ha^{-1}) from T_2 at Bhuapur and Mirpur, respectively due to reducing time and cost of production.

Effect of sowing date on the seed yield of coriander at charland

The experiment was conducted at charland of Kalirbazar in Mymensingh during the Rabi season of 2015-16 to find out the optimum sowing date for maximizing the seed yield of coriander. Four sowing dates viz. 30 October, 15 November, 30 November and 15 December were tested in this trial. The experiment was laid out in randomized complete block design with three replications. Delay sowing reduced seed yield of coriander by 4.97 to 32.30%. The highest seed yield (1.61 t ha^{-1}) was obtained from 30 October sowing which was identical with 15 November (1.53 t ha^{-1}) whereas the lowest (1.09 t ha^{-1}) from 15 December sowing. Maximum gross return (Tk.193200ha^{-1}) and gross margin (Tk. 136500 ha^{-1}) were also found with 30 October sowing.

Maize cultivation through conservation tillage practices in haor area of Kishoreganj

A field study was conducted at Shingpur haor, Nikli, Kishoreganj during the *rabi* seasons of 2014-15 and 2015-16 to observe the performance of minimum tillage on maize as well as introduce minimum tillage in maize growing area. Four treatments viz. zero tillage, minimum tillage (2-3 cm furrow), conventional tillage (8-10 cm depth) and conventional tillage with earthing up. The design was RCB with three replications. The variety was BARI Hybrid Maize-9. Among the treatments, zero tillage was maintained by bamboo stick and minimum tillage by iron tine. The maximum soil moisture was recorded from the zero tillage treatment. The highest yield (9.55 and 9.80 t ha^{-1}) was found from conventional tillage with earthing up which was more or less similar to others tillage system in both the years. The highest gross return (Tk. 124150 ha^{-1}) was calculated from minimum tillage practice. The MBCR (1.18) was also higher in minimum tillage which was more or less similar (1.05) in zero tillage.

Effect of different tillage methods for maize cultivation

An experiment was conducted at MLT site Kalapara, Patuakhali, in the *rabi* season of 2015-16 to verify the effect of different tillage method for Maize cultivation in coastal area of Patuakhali under farmers' field condition. Four different methods used. T_1= Seed sown with PTOS, T_2= Seed sown by strip tillage, T_3=Seed sown with bed planter, T_4= Conventional tillage/farmers practice. The highest seed yield (6.74 t ha^{-1}) was recorded from T_1 treatment and the lowest (4.08 t ha^{-1}) from T_2 treatment.

Effect of different amount of water hyacinth as mulch on potato and tomato at the saline soil of Noakhali

The experiment was conducted at the FSRD site, Hazirhat, Noakhali, during the *rabi* season of 2015-16 to observe the effect of different amount of water hyacinth as mulch on potato and tomato at the saline soil of Noakhali (AEZ-18). Potato variety (BARI Alu-7) and tomato variety (BARI Tomato-14) were used in this study. Different mulch treatments viz. T_1 = No mulch, T_2 =56 t ha^{-1}, T_3 = 62 t ha^{-1} and T_4 = 68 t ha^{-1} were tested in the expriment. Different amount of water hyacinth marked effect on soil moisture conservation to reduce the adverse effect of soil salinity. The maximum soil moisture (%) status and the lowest salinity level (dS m^{-1}) recorded both for potato and tomato at harvesting stage mulched with 68 t ha^{-1} water hyacinth. The highest yield 26.55 t ha^{-1} and 67.48 t ha^{-1} coupled with gross margin Tk. 166700 ha^{-1} and Tk. 649210 ha^{-1} obtained from T_4 treatment both for potato and tomato, respectively. Cultivation of Potato and Tomato with water hyacinth as mulch @ 68 t ha^{-1}

might be a good option to minimize the adverse effect of soil salinity as well as for higher yield and economic return at the saline soil of Noakhali.

Effect of plant spacing and variety of bottle gourd for leaf purpose

An experiment was conducted in the farmers' field at the FSRD site, Elenga, Tangail during the *rabi* season of 2014-15 and 2015-16 to find out the suitable variety and spacing of bottle gourd for leaf purpose and to increase production and farmers' income. Three varieties viz. V_1: BARI Lau-3, V_2: BARI Lau-4 and V_3: Local were tested with four planting spacing viz. S_1: 30cm×20cm, S_2: 35cm×10cm. S_3: 40cm×10cm and S_4: 40cm×20cm. Among the varieties the highest twig yield (40.47 t ha^{-1}) and gross margin (Tk. 539240 ha^{-1}) was obtained from BARI Lau-4 along with 30cm × 20cm plant spacing.

Performance of mulching and drip irrigation to mitigate soil salinity & conserve soil moisture in tomato field in coastal area

An experiment was conducted at MLT site Amtali, Borguna in the *rabi* season of 2015-16 to investigate the combined effects of drip irrigation and mulches to mitigate soil salinity, water use efficiency and yield performance of tomato. Four different treatments were T_1: drip irrigation with polythene mulch, T_2: drip irrigation with straw mulch T_3: drip irrigation without mulch T_4: conventional practice was used. The yield and yield-contributing characters in the polythene mulch treatment with drip irrigation were significantly higher compared to those in the unmulched treatments. The lowest level of salinity & high moisture content was recorded from T_1 treatments in every growth stage of crops ranges from 1.28-4.29 dS/m followed by T_2 treatments (1.26-5.24 dS/m) whereas soil salinity was much higher in the treatment T_3 (1.19-8.42 dS/m) & T_4 (1.23-8.63 dS/m). The yield of polyethylene mulching treatments was 46.04 t ha^{-1} and 26.67 t ha^{-1} for straw. The yield of conventional system with no mulch was 13.37 t ha^{-1}. The study thus reveals that drip irrigation with polythene mulch has an important role to mitigate soil salinity and moisture conservation of tomato field.

Effect of planting system on the yield of chilli at coastal area

The experiment was conducted at MLT site, Kuakata, Patuakhali during the *rabi* season of 2015-16 to find out appropriate planting system for chilli cultivation in coastal saline area. It was observed that transplanting of 40 days old polybag seedlings approach was better than others. From this method highest dry fruit yield (2.438 t ha^{-1}) and higher benefit was obtained. The trial should continue for the next year in other places in coastal area for validation.

Performance of maize under different tillage options in drought prone environment

An experiment was conducted at Shibpur, Puthia, Rajshahi during the *rabi* season of 2015-16 to study the performance of maize under different tillage option. Four treatments viz. T_1: Strip tillage, T_2: Dibbling method, T_3: Bed planting and T_4: Farmers' practice. Better establishment of the crop from the RCT based tillage systems positively contributed to yield and yield components of maize. However, among the treatment maximum grain cob^{-1} (604.48), grain weight cob^{-1} (187.9 g) and grain yield (12.54 t ha^{-1}) were recorded from dibbling method of planting. From the economic point of view higher yield in the RCT based tillage options contributed to higher economic return than conventional practice. However, the highest gross margin (Tk 152070 ha-1) and BCR (4.00) were obtained from dibbling method followed by strip tillage. Conventional practice showed comparatively poor performance incase of both yield and economic return.

Effect of irrigation on groundnut yield at the charland of Bhuapur, Tangail

An experiment was conducted at the charland of Jamuna river under Bhuapur upazila, Tangail during the *rabi* season of 2015-16 to evaluate the effect of irrigation on the yield of groundnut and increase yield and economic return of farmers. BARI Chinabadam-8 was selected as variety with four irrigation treatments viz., I_1= Irrigation at flowering stage, I_2= Irrigation at kernel pod^{-1} initiation stage, I_3= Irrigation at flowering and pod initiation stages and I_4= Non- irrigated. The highest gross margin (Tk. 64274 ha^{-1}) obtained from I_3 treatment and the lowest (Tk. 44657 ha^{-1}) from I_4 treatment. The highest groundnut yields increased 35.57% in I_3 treatment against I_4 (non-irrigated).

Effect of plant spacing on yield of sweet potato

The experiment was conducted at Muktagacha, Mymensingh during the *rabi* season of 2015-16 to study the effect of plant spacing on yield of sweet potato varieties. Three plant spacing viz. 60cm ×30cm, 50cm × 30cm and 30cm × 25cm (farmers' practice) were used as treatment variables. The experiment was laid out in a randomized complete block design with three dispersed replications. BARI SP- 11 and local sweet potato were used for this experiment. Result revealed that 50 cm ×30 cm spacing performed better and yielded the highest (20.53 t ha^{-1}) followed by 60 cm × 30 cm spacing (17.07 t ha^{-1}) and the lowest tuber yield (15.22 t ha^{-1}) was recorded with 30 cm × 25 cm plant spacing. Among the varieties BARI SP- 11 performed better and yielded highest (18.29 t ha^{-1}) over local cultivar (16.92 t ha^{-1}). The highest tuber yield (21.13 t ha^{-1}) was found from BARI SP-11 with 50 cm× 30 cm treatment combination and the lowest (15.00 t ha^{-1}) from local cultivar with 30 cm× 25 cm treatment combination. Economic analysis showed that the same spacing 50cm × 30 cm along with sweet potato var. BARI SP-11 gave the maximum gross return (Tk. 253560 ha^{-1}) and gross margin (Tk. 188060 ha^{-1}).

Impact assessment of climate change on major crop adaptation and resource utilization in farming systems

The impact assessment of climate change on major crop adaptation in Pabna was evaluated based on the secondary climate data and the response of farmers in the FSRD and MLT site during the year of 2015-16. The study indicates that the pattern of climate parameters particularly rainfall and temperature had been changed over the successive years as compared to 1990. The maximum temperature tended to decrease while minimum temperature exhibited increasing trend. The rainfall pattern of December, January and February demonstrated declining trend while the rainfall pattern in March remain unchanged as compared to 1990. The grain yields and area coverage of wheat and maize showed negative relationship with the difference between maximum and minimum temperature indicating the yield and area of crops declined with increasing temperature. The declining trend of farmers' response in favour of low temperature was noted in three seasons with pronounced in Rabi season. In general, farmers' response was noted in favour of increasing insect and disease infestation with the occurrence of new pest and disease in different crops as compared to 1990.

Effect of different tillage system on maize cultivation

The experiment was conducted during *rabi* season of 2014-15 at the MLT site, Pirganj, Rangpur to find out the suitable tillage system for maize production in Bangladesh. The experiment was arranged in RCBD with two tillage treatments in six (06) dispersed replicate blocks. The treatments included strip tillage and conventional tillage practice. Grain yield in both systems was almost similar. The total variable cost was higher in conventional tillage system than strip tillage system as it reduced the input costs and machinery use. The highest gross margin (Tk. 101430 ha^{-1}) was observed in strip tillage system and the lowest gross margin (Tk. 81200 ha^{-1}) from conventional tillage system.

Effect of planting time on production of mungbean

The experiment was carried out at MLT site of Kushtia sadar under Kushtia district during kharif season of 2013-14 and 2014-15 to find out the optimum planting time of mungbean cultivation in changing climate condition and to increase yield and farmers' income. Four treatments T_1= 28th February, T_2 = 10th March, T_3= 20th March, T_4= 30th March were used. Result indicated that T_2= 10th

March gave better yield (1.87 t ha^{-1}) among all other treatments and it also gave the highest returns (Gross return: Tk. 71250 ha^{-1} and gross margin (Tk. 33230 ha^{-1}).

Performance of bari developed summer tomato varieties

An on-farm trial was conducted at the FSRD site Elenga, Tangail during the *kharif* season of 2014-15 to evaluate the performance BARI developed summer tomato varieties in farmers' field. Two BARI developed hybrid tomato varieties viz. BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were evaluated in the study. The yield of BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were 34.67 t ha^{-1} and 31.23 t ha^{-1}, respectively.

Performance of minor spices on coastal area

The experiment was conducted in the farmer's field at FSRD site, Hazirhat, Noakhali (AEZ 18) during the *rabi* season of 2015-16 to see adoption yield potentiality and popularize the minor spices varieties in the coastal region (AEZ 18). Five minor spices viz., Fenugreek (BARI Methi-1 and BARI Methi-2), Black cumin (BARI Kalozira-1), Dill, Ajhowan and Coriander (BARI Dhania-1) were tested in this trial. Considering yield and economic return BARI Methi-2 is superior over BARI Methi-1. The average yield of BARI Methi-2 was recorded 1786 kg ha^{-1} which offered a gross margin of Tk.72035 ha^{-1}whereas BARI Methi-1 gave average yield of 1395 kg ha^{-1}. The average yield of BARI Kalozira-1, Dill, Ajhowan and BARI Dhania-1 were 812.7 kg ha^{-1}, 1420 kg ha^{-1}, 524 kg $ha^{-1}$and 1013 kg ha^{-1}, respectively and all of the minor spices were economically profitable. Soil salinity gradually increased up to maturity stage of the crop. Soil salinity varied from 0.82-5.32 dS m^{-1}, 0.72 - 4.81 dS m^{-1}, 0.75-5.61 dS m^{-1}, 0.62-4.95 dS m^{-1} and 0.98-5.71 dS m^{-1} for Fenugreek, Black cumin, Dill, Ajhowan and Coriander, respectively from emergence to maturity stage.

Performance of different hybrid maize varieties in rabi and kharif-i season

The experiment was conducted at MLT site Manikganj during the *rabi* season of 2014-15 and 2015-16 to evaluate the performance of hybrid maize varieties under farmer's field condition to promote their adoption in the newly developed Maize-Maize-Fallow cropping pattern in Manikganj. Hybrid maize varieties viz. BARI hybrid maize-9 and four locally popular imported hybrid varieties Elite, Pacific 984, NK-40 and Miracle were tested.

Performance of bari wheat varieties

The experiment was carried out in Dinajpur, Joypurhat, ManikganjMeherpur, Khulna and Faridpur during the *rabi* season of 2015-16 to see the yield of new wheat varieties in comparison to the widely grown check variety. The trial was carried out in a RCB design with 3 to 6 dispersed replications. The unit plot size was 4m x 5m and the varieties were BARI Gom-24, BARI Gom-25, BARI Gom-26, BARI Gom-27, BARI Gom-28, BARI Gom-29 and BARI Gom-30. The highest grain yield was recorded from BARI Gom-26 at Dinajpur, BARI Gom-30 at Joypurhat and Manikganj, BARI Gom-25 at Faridpur and Khulna and BARI Gom-28 at Meherpur. The days to maturity and lowest yield varied among the varieties from location to location.

Performance of bari hybrid maize varieties

The trial was carried out in the farmer's field of Ranigonj, Dinajpur, Dalupara hill valleys in Bandarban, Shingpur haor, Nikli upazilla of Kishoreganj, MLT site, Daulatkhan, Bhola, South Uzanchar, Goalanda Upazilla of Rajbari and Golapnagar char, Bheramara, Kushtia during the *rabi* season of 2015-16 to observe the performance and to popularize the BARI develop hybrid maize varieties among the farmers. Five hybrid maize varieties i.e., BARI Hybrid Maize-5, BARI Hybrid Maize-6, BARI Hybrid Maize-7, BARI Hybrid Maize-9, NK-40, Pacific-984 and P-3396 were included in the trial. Among the tested varieties BARI Hybrid Maize-9 gave the highest grain yield in Rajbari and Kushtia. NK-40 gave the highest grain yield which is statistically identical to BARI

Hybrid Maize-7 and BARI Hybrid Maize-9 in Dinajpur and Hybrid Maize-9 in Bandarban and BHM-9 and BHM-5 in Kishoreganj. Pacific-984 gave maximum yield which statistically similar to BHM-9 in Bhola. The lowest grain yield was recorded in BARI Hybrid Maize-5 in Dinajpur and Bandarban.

Performance of lentil varieties at farmers' fields

The trial was carried out at the MLT site, Muktagacha (Mymensingh), Satkhira, Kushtia sadar and Sariakandi (Bogra} during the *rabi* season of 2014-15 and 2015-16 to evaluate the performance of lentil varieties and to promote them among the farmers. The trial consisted of seven varieties viz. BARI Masur-4, BARI Masur-5, BARI Masur-6, BARI Masur-7, Binamasur-5, Binamasur-6 and a local check at Muktagacha and Satkhira. Five varieties viz. BARI Masur-4, BARI Masur-5, BARI Masur-6, BARI Masur-7 and BARI Masur-8 at Kushtia Sadar and Sariakandi. Results revealed that BARI Masur-7 yielded the highest (2167 kg ha^{-1} in 2014-15 and 1613 kg ha^{-1} in 2015-16) followed by Binamasur-5 (1900 kg ha^{-1} in 2014-15 and 1545 kg ha^{-1} in 2015-16) at Muktagacha. Whereas the highest seed yield was recorded from BARI Masur-6 of 2.03 t ha^{-1} and 0.94 t ha^{-1}, respectively in 2014-15 and 2015-16 at Satkhira. While BARI Masur-6 in 2014-15 and BARI Masur-8 in 2015-16 gave the higher seed yield at Kushtia sadar. Contrary, BARI Masur-6 gave the highest marketable yield and return followed by BARI Masur-7 at Sariakandi, Bogra in 2015-16. The lowest yield was obtained from the local variety at Muktagacha and Satkhira.

Performance of chickpea in charland area of Faridpur

A field trial was carried out in the farmer's field at FSRD site, Hatgobindapur, Faridpur during the *rabi* season of 2014-15 and 2015-16 to evaluate the performance of newly released chickpea varieties in Faridpur. The trial was laid out in a Randomized Complete Block Design having five dispersed replications. The variety BARI Chola-3, BARI Chola-5, BARI Chola-9 and Faridpur local as check were used in this trial as treatment. Among the tested varieties, BARI Chola-9 gave the highest seed yield (1.53 t ha^{-1}) followed by BARI Chola-3 (1.40 t ha^{-1}). The check variety Faridpur local gave the lowest yield (1.19 t ha^{-1}).

Performance of blackgram varieties at different locations

A field trial was conducted at Multilocation testing (MLT) site, Madhabpur, ChapaiNawaganj and Joypurhat during the Kharif-I, Kharif-II and *rabi* season, respectively of 2015-16 to select suitable variety of black gram (Maskalai) and to increase crop production as well as income of farmers. Three varieties of black gram viz. BARI Mash-1, BARI Mash-2 and BARI Mash-3 were employed in the trial. The highest number of seeds per pod and pod length were found in BARI Mash-2 at Madhabpur and BARI Mash-3 at Joypurhat. Although the seed yield was not influenced significantly, however, the seed yield of black gram was recorded higher in BARI Mash-3 (1.15 t ha^{-1} at Madhabpur, 1.48 t ha^{-1} at Joypurhat and1.25 t ha^{-1}at ChapaiNawaganj) compared to other varieties. The lowest grain yield found from local variety (1.18 t ha^{-1} and 0.95 t ha^{-1}) at Joypurhat and ChapaiNawaganj.

Performance of sesame varieties

An on-farm trial was conducted at multiplication testing (MLT) site, Zakiganj during the *Kharif-I* season of 2015 to evaluate the performance of BARI developed sesame varieties in Sylhet region. Four variety viz. BARI Til-2, BARI Til-3, BARI Til-4 and BARI Til-6 have been used in this trial. The experiment was laid out in a RCB design with six dispersed replications. Maximum seed yield (1.15 t ha^{-1}) was obtained from BARI Til-4 which was statistically followed by BARI Til-2 (1.14 t ha^{-1}). While the lowest seed yield (0.84 t ha^{-1}) by BARI Til-3.

Performance of linseed varieties

An experiment was conducted at MLT site, Zakiganj, Syhet and Killar Char, Companigonj, Noakhali during the year of 2015-16 to select a suitable variety of linseed for Sylhet and Noakhali area and to increase cropping intensity as well as income of the farmers. There were four linseed varieties i.e. BARI Tishi-1 (Nila), Noakhali-Local, Patuakhali-Local and Zakiganj-Local were used in the trial. Among the tested varieties, Tishi Zakiganj-local produced higher seed yield (0.94 t ha^{-1}) followed by Noakhali-local (0.81 t ha^{-1}), while Nila gave the lowest amount of seed (0.76 t ha^{-1}) yield in Zakiganj. In Noakhali, the highest seed yield was obtained in BARI Tishi-1 (1210 kg ha^{-1}) while the lowest seed yield from Noakhali- local (761 kg ha^{-1}). During the experimental period (November-March) the soil salinity ranged from 0.84 to 10.71 dS m^{-1}.

Performance of bari groundnut varieties in charland eco-systems

A field trial was conducted at the charland areas of Sariakandi, Bogra during the *rabi* season of 2015-16 to evaluate the performance of modern groundnut varieties under farmers' field condition. The experiment was laid out in a RCB design with six replications having plot size 5 m × 8 m. The seeds were planted 21 October 2015 at a spacing of 30 cm×15 cm. The crop was harvested during 24 March 2016. Out of the tested groundnut varieties, BARI Chinabadam-8 and BARI Chinabadam-9 gave the highest marketable yield and return over local.

Performance of BARI groundnut varieties in Dinajpur

An adaptive trial was conducted at Jharbari, Birgonj, Dinajpur during the year of 2015-16 to evaluate the performance of groundnut varieties against local. Groundnut var. BARI Chinabadam-8, Binachinabadam-4 and a local (Dhaka-1) were tested in the study. The unit plot size was 6m×5m. The seeds were sown on 8-10 September at a spacing of 30cm×15cm. Among the varieties, the highest nut yield was recorded in BARI Chainabadam-8 and the lowest in Dhaka-1.

Performance of onion varieties

The experiment was conducted at Mujibnagar, Meherpur and Kashinathpur, Pabna during the Rabi season of 2015-16 to evaluate the BARI Piaz-4 production ability over local variety. Bulb yield of BARI Piaz-4 was found slightly lower (23 t ha^{-1}) compared to Suksagar (25 t ha^{-1}) in Meherpur but higher in Pabna.

Performance of garlic varieties

An experiment was carried out at the MLT site, Rajbari sadar, Kushtia Sadar, Gabtali (Bogra), Chandpur, Madhabpur (Sylhet) and Atghoria (Pabna) during the *rabi* of 2014-15 and 2015-16 to evaluate the performance of BARI released garlic varieties under farmers' field condition and to popularize them among the farmers. The trial was laid out in in a randomized complete block design replicated three to seven farmers' field. Garlic varieties viz., BARI Rasun-1 and BARI Rasun-2 were tested against local variety as check. The highest bulb yield was obtained from the variety BARI Rasun-2 in all the sites except Kushtia sadar. BARI Rasun-2 provided 12%-54% higher yield over local variety across the locations.

Performance of chilli varieties

The experiment was conducted at MLT site, Daulatkhan, OFRD, Bholaunder AEZ-18 in *rabi* season 2015-16. Agronomic performance of BARI developed chilli varieties; BARI Morich-1 and BARI Morich-2, two Indian varieties; Debgiri and Annapurna and a local variety were tested under farmers' field condition to select suitable chilli variety(s) for Bhola region. Plant height, fresh chilli yield $plant^{-1}$ and dry chilli yield ha^{-1} differed significantly due to varietal effect. BARI Morich-1 produced the highest dry fruit yield (2.24 t ha^{-1}).

Performance of BARI developed capsicum variety

An adaptive trail was conducted in farmer's field under South surma upazila during the *rabi* season of 2015-16 to evaluate the performance of BARI released capsicum variety. BARI Mistimorich-1along with locally popular hybrid Winal-204 was used in this trial. Between two varieties, Winal-204 was produced higher fruit yield (14.03 t ha^{-1}) in farmers at Goptogao.

Performance of soybean varieties under rainfed condition

The experiment was conducted at MLT site, Daulatkhan, Bhola (AEZ-18) and MLT site, Laxmipur during the *rabi* season of 2015-16 to select suitable soybean variety under rainfed condition. BARI and BINA developed soybean varieties viz., BARI Soybean-5, BARI Soybean-6, Binasoybean-1, Binasoybean-2 and Sohag were tested at farmers' field under rainfed condition. Among the tested varieties, BARI Soybean-6 gave the highest seed yield (Bhola: 1.68 & Laxmipur: 2.64 t ha^{-1}). Yield of all varieties were satisfactory in both the sites.

Performance of different soybean varieties in charland area under rainfed conditon

Performance of soybean varieties were evaluated at the farmers' field of Farming System Research and Development (FSRD) site, Kushumhati, Sherpur during the year of 2016 under AEZ-9. Results obtained from the study indicated that the highest seed yield (1.57 t ha^{-1}) was recorded from BARI Soybean-5 and the lowest yield (1.40 t ha^{-1}) was obtained from Shohag variety.

Performance of BARI garden pea varieties

The experiment was conducted at Sadar, Bhola under AEZ-18 in *rabi* season 2015-16. Agronomic performance of BARI developed garden pea varieties BARI Motorshuti-1 and BARI Motorshuti-3 were tested under farmers' field condition to select suitable garden pea variety(s) for Bhola region. Plant height, green pods plant $^{-1}$ and green pods yield ha^{-1} differed significantly due to varietal effect. BARI Motorshuti-1 produced higher green pods yield (7.68 t ha^{-1}).

Performance of turmeric varieties

A field trial was conducted at the MLT site, Joypurhat, Satkhira and Bheramara, Kushtia during the year of 2015-16 to evaluate the performance of modern turmeric varieties under farmers' field condition. BARI Holud-4 produced the highest marketable yield at Joypurhat and Kushtia which was statistically similar with BARI Holud-2 and BARI Holud-3 at Joypurhat and BARI Holud-3 at Kushtia. In Satkhira, highest yield was recorded from BARI Holud-5 (39.17 t ha^{-1}) followed by BARI Holud-4 (37.67 t ha^{-1}). But percentage of dry matter was highest in local followed by BARI Holud-5 and BARI Holud-1 at Joypurhat. In Satkhira, dry matter percentage was highest in BARI Holud-5 (28%) followed by BARI Holud-3 (23%). The local variety gave lowest yield in all the locations.

Performance of minor cereals in saline area

The experiment was conducted at six (06) farmers field of Noakhali during the *rabi* season of 2015-16 to observe the performance and popularize BARI developed Foxtail Millet (BARI Kaon -2, BARI Kaon -3) and Proso Millet (Tushar) varieties in saline area (AEZ 18f). Among the tested varieties of Foxtail Millet, the maximum grain yield was observed in BARI Kaon-2 (1.49 t ha^{-1}) which is statistically similar with BARI Kaon-3 yield (1.45 t ha^{-1}). The yield of varieties was low in comparison to their yield potentiality might be adverse effect of soil salinity during late vegetative and early reproductive stage (9.25-14.80 dS m^{-1}). In case of Proso Millet, the yield (1.65 t ha^{-1}) was satisfactory level as it matured earlier (88 to 90 days) in comparison to Foxtail Millet (109 to 112 days) and escaped salinity (highest 8.76 dsm^{-1}in one replication during harvesting time).

Performance of BARI barley varieties in southern region of Bangladesh

A field experiment was carried out at multi location testing (MLT) site, Banaripara, Barisal under the supervision of On Farm Research Division, Barisal to evaluate the yield and productivity of BARI released barley varieties at southern region of Bangladesh. Three barley varieties viz. BARI Barley-2, BARI Barley-5 and BARI Barley-6 were selected for the trial. All the varieties performed better considering the grain yield and harvest index. The maximum grain yield was observed from the BARI Barley-5 (2.63 t ha^{-1}) and the minimum from the BARI Barley-6 (2.12 t ha^{-1}). BARI Barley-5 exhibited better performance than the others in the southern region in relation to early maturity (93 days), grain yield (2.63 t ha^{-1}), straw yield (1.47 t ha^{-1}) and harvest index (0.64).

Performance of sweet gourd varieties at farmers' field

A field trial was carried out at Char Jalkhana, Mymensingh sadar during the *rabi* season of 2015-16 to evaluate the comparative performance of BARI released high yielding sweet gourd varieties for this location. The trial consists of three varieties viz. BARI Mistikumra-1, BARI Hybrid Mistikumra-1 and local. The yield performance of BARI Mistikumra-1 and BARI Hybrid Mistikumra-1 appeared to be promising in the tested location. However, significantly the highest fruit yield was obtained from BARI Hybrid Mistikumra-1 (30.95 t ha^{-1}) followed by BARI Mistikumra-1 (26.32 t ha^{-1}) and the lowest yield was obtained from the local variety (17.44 t ha^{-1}).

Management of common cutworm on aroid at farmers' field condition

An experiment was conducted at the MLT site, Joypurhat during the year of 2015-16 to observe the performance of integrated management practice against common cut worm in aroid under farmer's field condition. Crop under pheromone trap based IPM approach resulted comparative lower leaf & stolon damage and produced higher yield than farmers practice (with insecticide).

Integrated pest management for controlling fruit borer of tomato

An experiment was conducted at farmer's fields of FSRD site, Jalalpur and MLT sites, Moulvibazar and Madhabpur during *rabi* season of 2015-16 to find out the effective control of tomato fruit borer. The treatments comprises of T_1: Sex pheromone traps for H. armigera @ 80 traps ha^{-1} + Hand picking of infested fruit with larvae, T_2: Sex pheromone traps for H. armigera @ 40 trap ha^{-1} + spraying of Bt powder @ 1.0g L^{-1} of water (3 sprays at 10 days interval starting from the first initiation of pest attack), T_3: Sex pheromone traps for H. armigera @ 40 trap ha^{-1} + Spraying of HaNPV @ 0.4g L^{-1} of water (3 sprays at 10 days interval starting from the first initiation of pest attack), T_4: Decis (0.5m L^{-1} of water) at 7 days interval and T_5: Untreated control. The lowest fruit infestation, both in number and weight was obtained from treatment T_2 followed by T_3. The highest fruit yield (45.75 t ha^{-1}) and marginal benefit cost ratio (3.78) was also obtained from T_2.

Integrated pest management of common cutworm on chilli at bogra region

An experiment was conducted at the MLT site, Gabtoli, Bogra during the year of 2015-16 to observe the performance of integrated management practice against common cut worm in chilli under farmer's field condition. Crop under pheromone trap based IPM approach resulted comparative lower fruit damage and produced higher yield than farmers practice (with insecticide). Number of captured moth/trap was higher at initial stage and gradually decreased with the progress of season.

Management of wilt disease of brinjal in the farmer's field

An experiment was conducted at farmer's field (acidic soil) of South surma, Sylhet during the kharif season of 2015-16 to find out the management strategy of *Ralstonia solanacearum* induced vascular bacterial wilt on eggplant. There were seven treatments viz., T_1= Poultry refuse @ 3 t ha^{-1}, T_2= Dolomite lime @ 1 t ha^{-1} T_3= Stable bleaching powder @ 20 kg ha^{-1}, T_4= T_1+ T_2, T_5= T_1+ T_3, T_6= T_2+ T_3 and T_7 =Control. Percent reduction of infected plants over control was highest in T_6 (60.80%) which was followed by T_5 (47.41%). Treatment T_6 also offered the highest fruit yield (22.83 t ha^{-1}) and gross margin (Tk. 305775 ha^{-1}).

Effect of fungicides against gummy stem blight disease of bottle gourd

The study was conducted at Mohinonda, Kishoreganj during the *kharif-II* season of 2015-16 to evaluate the efficacy of fungicides on gummy stem blight disease of bottle gourd. The treatments were

T_1: Farmers practice, T_2: Copper fungicide T_3: Tebuconazole and T_4: Tebuconazole with Trifloxystrobin. The lowest disease infection was observed in T_4 and the highest in Farmers practice. The maximum yield (83.22 t ha^{-1}) and MBCR (79.13) was also obtained from T_4 followed by T_2 (73.00 t ha^{-1}) and MBCR 65.00).

Effect of different antibacterial materials on bacterial wilt of brinjal

The experiment was carried out at char land of Malancha, Melandah, Jamalpur to find out the effect of different antibacterial materials on bacterial wilt of brinjal during *rabi* season of 2015-16. Three treatments viz. T_1=Recommended dose of Chemical fertilizers (RD) + stable bleaching powder @ 25 kg ha^{-1} with cowdung 5 t ha^{-1}, T_2= Recommended dose of Chemical fertilizers (RD) + poultry refuse @ 3 t ha^{-1} with 5 t ha^{-1} Cowdung, T_3= Farmers' practice were evaluated in the study. The highest fruit yield (53.33 t ha^{-1}) was recorded from T_1 and the lowest (31.67 t ha^{-1}) in farmers' practice.

Survey, monitoring and documentation of major insect pests of panikachu

A field survey was conducted in Joypurhat during the year of 2015-16 to document the insect and mite pests of aroid, their nature of damage and farmers perception about their management. Several insect-mite pests' viz. Common cutworm (*Spodoptera litura*), Leaf roller, Aphid, Grass hopper, Taro horn worm and red mite were found to attack the crop. Among the insect pests, Common cutworm causing serious damage compared to other pests. Other pests were occasional and caused minor damage.

Efficacy of fungicide against diseases of mustard in haor area

The study was conducted at Goroy, Nikli upazilla, under OFRD Kishoreganj during Rabi season of 2014-15 and 2015-16 evaluate the performance fungicide to control diseases of mustard and to popularize disease free mustard seed cultivation. The trial consisted four treatments viz; T_1: Seed treatment with rovral (3g/kg seed), T_2: Seed treatment with rovral + two times foliar application of rovral, T_3: one-time foliar application of rovral and T_4: Farmers practice (Without fungicide). The design was randomize complete block design with three replications. The highest diseases were found T_1 and T_4 treatments. The seed yield 1.49 t ha^{-1} gave from T_2 treatment and the lowest 1.19 t ha^{-1} was T_4 treatment in 2014-15. Similar result was found from 2015-16 seasons. It also provided maximum gross return Tk.54950 in T_2 treatment and the highest MBCR 1.06 in T_3 treatment.

Soil health improvement through inclusion of legume crops under existing agroforestry system

The agroforestry based experiment was conducted in Litchi orchard at Multi Location Testing site, Atghoria, Pabna during the year of 2015-16. Three leguminous crops and control (omission of pulse) viz. T_1= Lentil (BARI Masur-6), T_2= Pea (Nator local 2) and T_3= Grass pea (BARI Khesari 1) along with control (omission of legume) were considered as treatments with litchi orchard in this trial. The experiment was carried out in a RCB design with three replications. Higher seed yield was obtained from field pea followed by lentil and lower from grass pea. Stover yield was produced more by field pea followed by grass pea. Lentil based system resulted maximum no. of fruits $plant^{-1}$ of litchi. In terms of economic return, higher gross return and gross margin was attained from lentil and litchi based agroforestry system.

Performance of potato yam as affected by tree species and planting distance from tree bases under agroforestry system

A homestead based agroforestry trial was carried out with potato yam at Farming Systems Research and Development (FSRD) site, Pushpopara, Pabna during the year of 2015-16 to observe the effect of tree species and yam planting distance from the supporting trees on yield and plant performance of potato yam in homestead area. Three supporting tree species viz. T_1= Mahogani, T_2= Drumstick and T_3= Jiga and three planting distance from supporting tree bases viz. D_1= 50cm, D_2= 75cm and D_3= 100cm were considered for the trial. Two separate experiments were conducted with two species of potato yam i.e. D. bulbifera and D. alata. The tuber yield of both yam species were significantly affected by both tree species and planting distance, where both performed better on Drumstick tree with 100cm planting distance.

Yield potentiality of different cropping patterns in mango orchard as agroforestry system

The agroforestry based experiment was conducted at Multilocation Testing (MLT) site Khalashpir, Pirganj, Rangpur to find out the profitable cropping pattern under mango orchard. Three cropping patterns viz., Potato-Mungbean-T.Aman, Potato-Mungbean-Bitter gourd and Wheat-Mungbean- Bitter gourd were tested during Rabi 2014-15 to Kharif-II 2015. Potato-Mungbean-Bitter gourd cropping pattern was found more promising and it produce the highest rice equivalent yield (REY) (51.43 t ha^{-1}) with maximum gross margin (328660 Tk.ha^{-1}) and the lowest REY (24.95 t ha^{-1}) with minimum gross margin (98300 Tk.ha^{-1}) was obtained from Potato-Mungbean.T.Aman cropping pattern.

Performance of early planted tomato varieties under agroforestry system

An experiment was conducted at Agricultural Research Station, Alamnagar, Rangpur during late *kharif-II* to Early *rabi* season of 2015-16 under agroforestry system to evaluate the suitability and performance of BARI developed summer hybrid tomato varieties and lines in early planting condition. Three newly developed advance lines along with BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were tested under mango orchard and open field condition. The taste of early planted tomato especially planted in open field condition was become relatively sourer as the total soluble solids decreased (4.11%). Tomato cultivated in orchard environment was produced more fruits per plant (12.13), weight per fruit (63.83 g) and fruit yield (15.38 t ha^{-1}) compared to open field environment at early fruiting stage but later stage the trend was reverse and finally the total yield stranded 37.36 t ha^{-1} in orchard environment and 33.75 t ha^{-1} in open field condition. Mango tree shade can cut light intensity about 88% and 78% in the morning and noon, respectively and it can minimize the canopy temperature about 6.44% during early hot period. Among the tested lines and varieties, the highest number of fruits per plant was obtained from BARI Hybrid Tomato-8 (12.70) at early fruiting stage but later stage it was highest in BARI Hybrid Tomato-4 (20.93). The highest total fruit yield (41.11 t ha^{-1}) was obtained from BARI Hybrid Tomato-8 and the lowest yield (30.39 t ha^{-1}) from line CLN-3324A × 3125-O-19. Higher tomato fruit yield with higher market price at early fruiting stage contributed more to get higher value (gross margin 738969 Tk. ha^{-1}) from mango orchard based agroforestry system compared to open field condition.

On-farm Trials with Advanced lines and Technologies

On-farm trial of BARI released Bt brinjal varieties

The field trial was conducted at 25 districts of Bangladesh such as Dinajpur, Rangpur, Bogra, Rajshahi, Pabna, Kushtia, Meherpur, Jessore, Khulna, Bhola, Sherpur, Mymensingh, Kishoreganj, Tangail, Manikganj, Gazipur, Narsingdi, Comilla, Faridpur, Patuakhali, Sylhet, Gopalganj, Noakhali, Bandarban and Chittagong during 2015-16 to observe the performance of transgenic Bt brinjal varieties at the farmers' field. Tested four BARI Bt brinjal varieties performed better against non Bt counterparts, reduced brinjal shoot and fruit borer infestation, produced maximum healthy fruit and offered higher gross margin in all locations. Shoot infestation by BSFB was not found in Bt varieties in all the locations except Hathazari. These varieties showed 0-2.86% fruit infestation by number and 0-3.2% fruit infestation by weight against 14.21-68.92% fruit by number and 10.9-80% fruit infestation by weight in non-Bt counterparts.

Performance of BARI Bt Begun-1: The mean yield of BARI Bt Begun-1 was 22.4 t/ha^{-1} with a range of 20.1 to 23.9 t/ha^{-1} over three locations. The higher marketable fruit yield of brinjal was recorded from Noakhali (23.9 t ha^{-1}) followed by Sylhet (22.9 t ha^{-1}). The lower yield was recorded from

Dinajpur (20.3 t ha^{-1}). The BSFB infestation in shoot ranged from 0 to 1.15 percent and that in fruit (by no.) ranged from 0 to 2.86 percent as well as Infestation in fruit (by wt.) ranged from 0 to 2.40 in BARI Bt Begun-1 against 35.3 percent shoot and 57.9 percent fruit infestation (by no.) along with 41.1 percent (by wt.) in non-Bt counterpart BARI Begun-1 (Uttara). The average yield of non-Bt BARI Begun-1 (Uttara) was 12.2 ton per hectare.

Performance of BARI Bt Begun-2: Comparatively better yield performance was observed in BARI Bt Begun-2 across the country. The mean yield of BARI Bt Begun-2 was 29.1 t/ha^{-1} with a range of 19.0 to 46.9 t/ha^{-1} over the 14 locations. The higher marketable fruit yield of brinjal was recorded from Kishoregonj (46.9 t ha^{-1}) and Gopalganj (45.9 t ha^{-1}) followed by Mymensingh (40.3 t ha^{-1}). The lower yield was recorded from Narsingdi (19.0 t ha^{-1}) followed by Comilla (20.8 t ha^{-1}) may be due to less population of plants for wilting. BSFB infestation in shoot ranged 0 to 0.83 percent and in the fruit (by no.) 0 to 0.97 percent as well as infestation (by wt.) varied 0 to 1.66 percent in BARI Bt Begun-2. The non-Bt counterpart of the variety BARI Begun-4 (Kazla) was infected by BSFB both in shoot and fruit and infestation observed on an average 31.26 percent shoot and 50.43 percent fruit (by no.) along with 46.41 percent (by wt.) was infected by BSFB. It was obtained marketable yield of 16.5 ton per hectare.

Performance of BARI Bt Begun-3: BARI Bt Begun-3 was cultivated in 15 districts. The mean yield of BARI Bt Begun-3 was 25.9 t/ha^{-1} with a range of 16.5 to 35.4 t/ha^{-1}. The higher marketable fruit yield of BARI Bt Begun-3 was recorded from Gopalganj (35.4 t ha^{-1}) and Kishoregonj (35.4 t ha^{-1}) followed by Meherpur (31.4 t ha^{-1}). The lower yield was recorded from Jossore (16.3 t ha^{-1}) due to less population of plants for serious wilting problem. The BSFB infestation in shoot ranged from 0 to 0.65 percent and in fruit (by no.) range from 0 to 1.20 percent along with infestation in fruit (by wt.) varied 0 to 0.84 percent in BARI Bt Begun-3. On the other hand 37.27 percent shoot and 56.13 percent fruit (by no.) as well as 37.46 percent fruit (by wt.) infestation in non-Bt counterpart BARI Begun-5 (Nayantara). The average yield of BARI Begun-5 (Nayantara) was 11.1 t/ha^{-1}.

Performance of BARI Bt Begun-4: BARI Bt Begun-4 was cultivated in 17 districts. The mean yield of BARI Bt Begun-4 was 22.5 t/ha^{-1} with a range of 12.0 to 31.3 t/ha^{-1} over the 17 locations. The higher marketable fruit yield of BARI Bt Begun-4 was recorded from Satkhira (31.3 t ha^{-1}) followed by Meherpur (30.6 t ha^{-1}) and Shyampur, Rajshahi (29.6 t ha^{-1}). The lower yield was recorded from Faridpur (12.0 t ha^{-1}) followed by Jessore (13.4 t ha^{-1}) may be due to less population of plants for wilting. No BSFB infestation in shoot (0-2.8 percent) was observed. BSFB infestation was recorded at 0 to 3.2 percent on fruit (by no.) while infestation on fruit (by wt.) varied 0 to 2.8 percent at BARI Bt Begun-4 variety over the locations. The non-Bt counterpart of the variety BARI Begun-6 was infected by BSFB both in shoot and fruit. On an average 27.53 percent shoot and 47.52 percent fruit (by no.) along with 39.18 percent (by wt.) were infected by BSFB and obtained marketable yield of 11.1 ton per hectare in case of non-Bt brinjal variety (Table 5).

Non target Pest incidence: Different sucking pests like Whitefly, Jassid, Aphid, Mite etc. and diseases (Fusarium wilt, Phomopsis blight, Bacterial wilt etc.) was observed in some locations. These pests were controlled by appropriate management approaches.

Farmers' Opinion

- As the fruits of Bt brinjal varieties are free from infestation, no sorting is required.
- Production cost becomes lower for no application of insecticides for BSFB. Higher gross margin obtained due to BSFB free fresh healthy fruits.
- Many farmers who have visited Bt brinjal plots demanded seeds for cultivation.
- BSFB free smooth and good looking fruit created an excellent feelings and curiosity among the farmers.

Adaptive trials with low water required white grain hybrid maize in high Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Godagai, Rajshahi during *rabi* season of 2015-16 to observe the performance of locally developed promising low water required hybrid maize and selection of short stature best one (s) for Barind areas. Four hybrids viz. P_1xP_4, P_1xP_7, P_2xP_5 and Shuvra were evaluated in the study. All hybrids received single irrigation before flowering. Shuvra took the shortest days for flowering and maturity and produced highest plant and ear height. Hybrids P_1xP_4 and P_1xP_7 had the shortest plant and ear height. The maximum yield was obtained from the hybrid P_2xP_5 which was statistically similar with P_1xP_4 and P_1xP_7 and the lowest in Suvra. At maturity, P_2xP_5 was remained green and Suvra had a lodging tendency. Farmer opined that white maize flour can be consumed mixing with that of wheat (wheat: maize = 2:1) and its taste is slightly sweet. At maturity stage, P_2xP_5 was remained green and its top part can be used as fodder.

Adaptive trials selected high yielding heat tolerant HTMA field corn hybrids in high Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Godagai, Rajshahi during Rabi season of 2015-16 to find out the suitable heat tolerant hybrid maize variety for obtaining higher yield and economic return in High Barind Tract. Four hybrids viz. HTMA19, HTMA22, 981 and NK40 were evaluated in the study. All the hybrids matured with the same duration. The highest plant and ear height was observed in 981 while the lowest in NK40. The highest grain yield was also obtained from 981 (10.26 t ha^{-1}) and lowest in NK40 (8.45 t ha^{-1}) while HTMA19 and HTMA22 showed similar and intermediate yield performance which were 10.01 and 9.85 t ha^{-1}, respectively. Farmer's choose hybrids 981 and HTMA22 for their higher yield.

Adaptive trials with BARI barley varieties in southern belt and Barind Tract

The trial was conducted at the farmer's field of Barind, Rajshahi and Noakhali during *rabi* 2015-16 with a view to select high yielding barley varieties/advance lines for drought and saline area areas. Two barley varieties namely BARI Barley-3, BARI Barley- 6 and three advance lines viz. BHL-10, BHL-15 and BHL-19 were selected for drought areas and five varieties viz. BARI Barley-3, BARI Barley-4, BARI Barley-5, BARI Barley-6 and BARI Barley-7 were evaluated in saline areas. Among the tested varieties/lines, BHL-19 (2.11 t ha^{-1}) and BARI Barley-6 (2.08 t ha^{-1}) produced maximum grain yield in drought areas and BARI Barley-6 (1.51t ha^{-1}) performed better in saline areas.

Overall performance of barley varieties/lines was good in respect of yield under drought prone Barind areas. Farmers preferred BHL-19 and BARI barley-6 for their better yield in Barind area. Farmers are not interested to grow barley at Noakhali due to difficulty in threshing, winnowing and processing.

Adaptive **trials with BARI barley varieties in char areas**

The trial was conducted in the farmers' field of MLT site Ulipur under OFRD, Rangpur during 2015-16 to evaluate barley varieties in the char land areas. Four different BARI barley varieties (BARI Barley-3, BARI Barley-4, BARI Barley-5 and BARI Barley-6) were used in the study. The highest grain yield (2.36 t ha^{-1}) was recorded from BARI Barley-5 and the lowest (1.81 t ha^{-1}) in BARI Barley-4.

Farmers encouragesd was good with BARI Barley-5 as those exhibited higher yield over the others varieties. They were satisfied for higher gross margin from these varieties.

On -Farm Trial of BARI Developed Summer Eggplant Variety

The experiment was conducted at the FSRD site, Lahirirhat, Rangpur during *kharif* season, 2015-2016 to observe the performance of summer brinjal varieties under farmers' field condition. Two varieties of brinjal viz. BARI Begun-10 and local were tested. BARI Begun-10 gave higher yield (34.64 t ha^{-1}) compared to the local variety (22.51 t ha^{-1}). The higher gross margin (Tk. 228130 ha^{-1}) were obtained from BARI Begun-10. The lower gross margin (Tk. 82570 ha^{-1}) were obtained from local variety.

Pest incidence: Damping off disease was observed and was controlled by applying Bavistin @ 1 g L^{-1} of water. Cut warm was controlled by Dursebern @ 2 ml L^{-1} water at the seedling stage.

Among the varieties, farmers preferred BARI Begun-10 due to its higher yield, fruit size and high market demand.

ON-farm trial of BARI developed winter tomato varieties

The trail was conducted at Rangpur, Rajshahi, Comilla, Barguna, Satkhira, Pabna, Kushtia, Sylhet, Bandarban, Hathazari, Noakhali and Narsingdi during *rabi* season of 2015-16 to evaluate the performance of BARI developed tomato varieties at different locations of the country. Two varieties viz., BARI Tomato-14, BARI Tomato-15 along with Local (Check) were evaluated in the study. BARI Tomato-15 produced highest yield at Shyampur, Rajshahi (74.64 t ha^{-1}), Satkhira (65.57 t ha^{-1}), Pabna (68.57 t ha^{-1}), Sylhet (45.30 t ha^{-1}) and Banderban (78.74 t ha^{-1}). BARI Tomato-14 produced higher yield in at Comilla (71.75 t ha^{-1}), Rangpur (78.83 t ha^{-1}), Kushtia (79.5 t ha^{-1}), Patuakhali (57.2 t ha^{-1}), Noakhali (59.40 t ha^{-1}) and Narsingdi (71.36 t ha^{-1}) but local variety performed better in Shyampur, Rajshahi (78.22 t ha^{-1}), Patuakhali (81.5 t ha^{-1}) and Pabna (69.03 t ha^{-1}).

Disease incidence

Kushtia: The tomato field was sprayed by applying Ridomil Gold in 3 times and Admire in 3 times.

Hathazari: The highest incidence of bacterial wilt disease was recorded in local cultivar (10.31.0%) followed by BARI tomato-15 (8.44%) and BARI tomato-14 (5.31%).

Farmers of Rangpur, Hathazari, Shyampur, Rajshahi, Noakhali, and Narsingdi were interested to grow BARI developed tomato varieties i.e. BARI Tomato-15 and BARI Tomato-14 due to their higher yield but farmers of Kushtia preferred BARI tomato-14.

On-farm trial of BARI developed winter hybrid tomato varieties

The experiment was conducted at Comilla, Rangpur, Pabna, Shyampur, Bandarban, Mymensingh, Norsingdi, Patuakhali and Satkhira during *rabi* season of 2015-16 to evaluate the performance of BARI released hybrid tomato varieties at farmer's field. Two hybrid tomato varieties viz., BARI Hybrid Tomato-5 and BARI Hybrid Tomato-7 along with local (hybrid) were evaluated. BARI Hybrid Tomato-5 performed better (average 71.72 t ha^{-1}) in all locations except Patuakhali (92.7 t ha^{-1}) where local variety out yielded BARI Tomato varieties.

Pest incidence: Rangpur: Lab blight discase of tomato was observed and was controlled by applying Ridomil Gold @ 2 g L^{-1} of water starting from 25 days after transplanting (DAT) and Secure alternatively up to 65 DAT. White fly, Jassid and Aphid attack was noticed. Admire @ 0.5 gm L^{-1} and Desis 1 ml L^{-1} water was applied to control from those insects.

Farmers of Comilla, Mymensingh, Satkhira, Pabna, Bandarban and Patuakhali showed their interest to grow the BARI Hybrid Tomato-5 for its higher yield, uniform size, attractive color and higher economic return but farmers of Narsingdi preferred both BARI Hybrid Tomato-5 and BARI Hybrid Tomato-7.

On-Farm trial of BARI developed summer hybrid tomato variety

An on-farm trial was conducted at Comilla, Shyampur, Noakhali, Jessore and Narsingdi during *kharif* season of 2015 to evaluate the performance of BARI developed summer hybrid tomato in farmers' field. Two BARI developed summer hybrid varieties viz. BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were evaluated in the study. BARI Hybrid Tomato-4 performed better in Comilla (17.32 t ha^{-1}) and Jessore (71.98 t ha^{-1}) whereas BARI Hybrid Tomato-8 produced higher yield in Shyampur (35.39 t ha^{-1}), Noakhali (28.71 t ha^{-1}) and Narsingdi (30.78 t ha^{-1}).

Pest incidence:

Comilla: The highest percentage of plant mortality due to bacterial wilt were recorded from BARI summetr Hybrid Tomato-8 (34. 58%) than BARI summer Hybrid Tomato-4 (25.60%).

Shyampur: About 10.33% bacterial wilted plant was observed in BARI summer Hybrid Tomato-8 and 11.17% in BARI Hybrid Tomato 4. 14.17% virus infected plants were observed in BARI Hybrid Tomato 4 and 13.33% in BARI Hybrid Tomato-8.

On-Farm trial of BARI developed bottle gourd variety for summer season

The trial was conducted at Rangpur, Narsingdi, Hathazari, Sherpur, Comilla and Pabna during *kharif* season of 2015 to evaluate the performance of BARI developed high yielding summer bottle gourd variety in the farmer's field. BARI Lau-4 and local (check) were used in this trial. BARI Lau-4 (average 49.17 t ha^{-1}) gave higher yield compare to their local variety (average 38.21 t ha^{-1}) in all the locations.

Farmers of all the locations preferred BARI Lau-4 exhibited good shape, size, colour and higher yield over the local cultivar. They stored seed to cultivate BARI Lau-4 in the next year. They were happy to get off season gourd during Kharif 2 season when other vegetables are less available.

On-Farm trial of BARI developed ridge gourd variety

A field trial was conducted at Comilla and Mymensingh during *kharif* season of 2015 to evaluate the performance of BARI Jhinga-1 with a local cultivar. The ridge gourd var. BARI Jhinga-1(average 11.23 t ha^{-1}) produced the highest yield in all the locations compared to local variety (average 8.08 t ha^{-1}).

Pest and Disease Infestation

Mymensingh: Sporadically the crop was infested by downy mildew and it was controlled by spraying of Thiovit @ 2g L^{-1} water at 10 days interval. Sevin 2 g L^{-1} water was applied for controlling of red pumpkin beetle.

Comilla: BARI Jhinga-1 was comparatively less infested by pest and tolerant to diseases. BARI Jhinga-1 is higher yielder, short duration and preferred by the consumers due to its green colour and softness than the local variety both at Comilla and Mymensingh. So the farmers are interested to cultivate this variety in the next year.

On-Farm trial of BARI developed country bean variety

The experiment was conducted at Khulna, Rangpur, Sylhet, Bandarban, Noakhali and Tangail during *rabi* season 2015-16 to evaluate the performance of BARI developed country bean variety BARI Shim-6 along with local variety under farmer's field condition. BARI Shim-6 produced higher pod yield compared to local variety in all locations except Rangpur and Jalalpur, Sylhet where local variety (11.85 t ha^{-1}) produced higher yield than BARI shim-6 (11.62 t ha^{-1}). The yield of BARI Shim-1 was the highest at Tangail (17.68 t ha^{-1}) followed by BARI Shim-6 (15.30 t ha^{-1}).

Pest and diseases infestation

Rangpur: BARI Shim-6 was infested with virus. Bean Aphid attacked in the field and was controlled by marshal @ 2ml L^{-1} water from 25 DAT to 60 days after transplanting DAT. Ripcord @1ml L^{-1} was applied to control fruit borer. Leaf spot disease was appeared and was controlled by spraying of Bavistin @1gm L^{-1} water thrice at 7 days interval starting from 28 DAT.

Sylhet: Yellow mosaic virus was infested in some plants at later stage of plant growth but it was less in local Patashim. Aphid infestation was severe in both cases. Pod borer insect was also recorded but it was not so severe.

Tangail: BARI Sheem-7 was attacked by pod borer insect.

Farmers of all the locations opined that country bean var. BARI Shim-6 is high yielding. They are interested to cultivate this variety in the next year because of high yields and more profitable than local variety. But Sylhet farmers like locally popular exportable variety Goalgada instead of BARI Shim-6.

Adaptive trial of BARI developed boroccoli variety

The experiment was conducted at farmers' field of Comilla, Patuakhali, Rangpur, Pabna and Noakhali district during the *rabi* season of 2015-16 to test the performance of BARI Broccoli-1 against locally cultivated hybrid variety (Early Green). The yield potentiality of the BARI Broccoli-1 was higher in Comilla (20.53 t ha^{-1}) and Noakhali (14.53 t ha^{-1}). But Local hybrid variety out yielded BARI developed variety at Patuakhali (15.6 t ha^{-1}), Rangpur (26.83 t ha^{-1}) and Pabna (16.91 t ha^{-1}).

Pest and disease infestation: Damping off disease was observed and was controlled by applying Bavistin @ 1 g L^{-1} of water and Cut warm was controlled by Dursebern @ 2 ml L^{-1} water at the seedling stage in Rangpur.

Farmers' opinion

The shape, size and color of BARI Broccoli-1 was preferred by the farmer's due to high yield but they opined BARI developed variety was less compact than the locally grown hybrid. In Patuakhali, market price was very low. In Pabna, broccoli is completely new vegetable to that area and market price was also low. Rangpur farmers preferred locally grown hybrid broccoli because of its yield, compactness and gross margin was high than BARI broccoli-1 variety. Farmers of Noakhali were confused about the yield and market demand.

On-Farm trial of BARI developed hybrid pumpkin variety

The experiment was conducted at MLT site, Satkhira and at MLT site, Kuakata, Patuakhali and at Char Jalkhana, Mymensingh sadar during Rabi season of 2015-16 to evaluate BARI developed high yielding hybrid pumpkin variety. BARI Hybrid Mistikumra-1 was tested against BARI Mistikumra-1 in farmer's field to evaluate their performance. BARI Hybrid Mistikumra-1(average 36.22 t ha^{-1}) gave higher yield compare to existing BARI Mistikumra-1 (average 32.16 t ha^{-1}) at all the locations.

Farmers of Satkhira preferred BARI Mistikumra-1 due to its higher yield but due to smaller size they did not like much. Farmers of Patuakhali and Mymensingh were satisfied with the yield of BARI Hybrid Mistikumra-1 that gave more number of fruit but fruit size was smaller than locally cultivated hybrid.

ON-Farm trial of BARI developed spinach varieties

An experiment was conducted at the farmers' field of Comilla, Patuakhali, Pabna, Noakhali and Rangpur district during the *rabi* season of 2015-16 to evaluate the performance and popularize the newly developed BARI Palongsak-1 variety among the farmers. BARI Palongsak-1 and Local variety were included as check in the experiment. Spinach var. BARI Palongsak-1 produced the higher yield than local variety at Comilla (12.31 t ha^{-1}), Patuakhali (15.0 t ha^{-1}), Noakhali (24.52 t ha^{-1}) and Rangpur (9.71 t ha^{-1}) but at Pabna (10.12 t ha^{-1}) local variety outyielded BARI developed varirty.

Disease Infestation

Noakhali: Anthracnose leaf spot was observed higher in BARI Palang sak-1 in comparison to local variety. About 20% plant of BARI Palang sak-1 were infected whereas it was less than 5% plants in local variety. Copper fungicide (Champion 77 WP @) 2g 10 L^{-1} at 3 days interval) controlled the infection successfully.

Rangpur: There was no remarkable disease and pest infestation in spinach crop field.

Farmers of all locations are satisfied with the yield of BARI Palongsak-1 as this variety comparatively less infested by pest and tolerant to diseases. The leaves of BARI Palongsak-1 were soft and succulent. But farmers of Pabna didn't show their interest to BARI spinach variety as it exhibited lower yield compared to that of local variety.

On-Farm trial of BARI developed snake gourd variety

An experiment was conducted at the farmers' fields of Comilla and Mymensingh district during the *kharif* season of 2015 to evaluate the performance and to disseminate the BARI developed snake gourd variety (BARI Chichinga-1) among the farmers. At Comilla, local variety (18.16 t ha^{-1}) performed better over the BARI Chichinga-1 (17.23 t ha^{-}) ^{1}in all aspects except number of fruits $plant^{-1}$ whereas at Mymensingh, BARI Chichinga-1 (15.66 t ha^{-1}) produced higher yield than local variety (9.88 t ha^{-1}).

Pest and Disease Infestation: The crop was infested by downy mildew and it was controlled by spraying of Thiovit @ 2g L^{-1} and Calixcin @ 1g L^{-1} water at 10 days interval. Sevin @ 2 g L^{-1} was applied for controlling of red pumpkin beetle in Mymensingh.

Farmers' opinion: Farmers' of Comilla and Mymensingh chosen the variety BARI Chichinga-1 for its green color, narrow shape and 7-8 days earlier than local variety. So, the farmers are interested in cultivating this variety in next year.

Adaptive trial of advanced lines of rapeseed

A field trial was carried out at Pabna, Comilla, Netrakona and Gopalganj during *rabi* season of 2015-16 to evaluate the comparative performance of two advanced lines of rapeseed. The trial consisted of two advanced lines BC-2010-01 and BC-2010-02 along with two varieties as check viz. BARI Sarisha-14 and Tori-7. Performance of BC-2010-01 and BC-2010-02 and BARI Sarisha-14 appeared to be promising in the tested locations. Among the lines, BC-2010-02 produced the highest yield in Pabna (1.67 t ha^{-1}), Netrakona (2.3 t ha^{-1}) and Gopalganj (1.75 t ha^{-1}) and BC-2010-01 in Comilla (1.37 t ha^{-1}).

Farmer's opinion: Farmers of Pabna, Comilla, Netrakona opined that all advanced lines had high yield potentiality, short duration and less pest and diseases infestation similar to BARI Sarisha-14. Farmers of Gopalganj prefer BARI Sarisha-14 due to high yield than others variety/lines. Farmers show keen interest on BARI Sarisha-14.

Adaptive trial of advanced lines of sesame

The trial was conducted at Khulna, Gopalganj, Kushtia, Patuakhali and Faridpur during 2015-16 to evaluate the performance of advanced lines of sesame along with BARI Til-3 and BARI Til-4 (check) under farmers' field condition. None of the tested advance lines/varieties performed better in all location. BARI Til-4 performed better over advance lines in Khulna (1.35 t ha^{-1}), advance lines Ses-2010-0IR (2.20 t ha^{-1}) and Ses-9768 (1.90 t ha^{-1}) produced higher yield than BARI Til-4 (1.80 t ha^{-1}) in Gopalganj, BARI Til-4 (1.6 t ha^{-1}) and Ses-JP-58(Y) (1.51t ha^{-1})performed better in Kushtia, BARI Til-3 (1.1 t ha^{-1}) and Ses-JP58 (1.09 t ha^{-1}) offered higher yield in Patuakhali and in Faridpur, BARI Til-4 (1.53 t ha^{-1}) and Ses-0570 (1.51 t ha^{-1}) provided higher yield.

Khulna: Farmers were satisfied with the performance of BARI Til-4 but the market price is lower in comparison to local. Because the seed coat color of BARI Til-4 is brown color, which is sold almost half price of local black colored sesame.

Gopalganj: All the variety and lines satisfied farmers due to higher yield over local variety. Farmers showed highly interest on Ses 020100IR and Ses 9768.

Kushtia: Farmers preferred BARI Til-4 due to its higher seed yield, attractive colour and higher demand. They also preferred Ses-JP-58(Y) due to higher market price and white colour. They were interested to cultivate BARI Til-4 and Ses-JP-58(Y) in next time.

Patuakhali: Farmers were interested to cultivate BARI Til-3 and Ses-JP58 (1.09 t ha^{-1}). Less disease infestation was found. Fallow land can be utilized in *kharif*-1 season.

Faridpur: Farmers expressed their positive opinion on BARI Til-4 variety and Ses-0570 line due to satisfactory yield.

Performance of selected groundnut genotypes in charland areas

The experiment was conducted at Sherpur and Gopalganj during *rabi* season of 2015-2016 to evaluate the performance of suitable high yielding groundnut lines. In Sherpur, four chinabadam varieties viz., BARI Chinabadam-8, BARI Chinabadam-9, Dhaka-1, BINA Chinabadam-4 and six advance lines viz., ICGV-91114, ICGV-07220, ICGV-05158, ICGV-07219, ICGV-96346, ICGV-06279 were evaluated whereas in Gopalganj, nine lines viz. ICGV-97229, ICGV-97232, ICGV-95070, ICGV-96390, ICGV-1224-G-75, J1987015-SL-1, ICGV-87860-G3, ICGV-95399, ICGV-96175 and Dhaka-1 (as check) were selected in the study. In Sherpur, BARI Chinabadam-8 (2.24 t ha^{-1}) produced higher yield over all advanced lines but in Gopalganj, advanced line ICGV-95399 (2.85 t ha^{-1}), ICGV-95070 (2.70 t ha^{-1}) and ICGV-87860-G3 (2.55 t ha^{-1}) performed better.

Farmer's opinion

Sherpur: Farmers were highly satisfied with BARI Chinabadam-8 for its higher yield as well as return. They also chose ICGV-91114 for higher yield.

Gopalganj: Farmers preferred ICGV-95399 due to its higher yield and bigger nut size. They urged availability of seed in time.

Adaptive trial of BARI groundnut varieties

An adaptive trial was conducted at Jharbari, Birgonj, Dinajpur during 2015-16 to evaluate the performance of groundnut varieties against local. BARI Chinabadam-8, Binachinabadam-4 and a local (Dhaka-1) were tested in the study. Among the varieties, the highest nut yield was recorded in BARI Chainabadam-8 (1917 kg ha^{-1}) and the lowest in Dhaka-1 (1477 kg ha^{-1}. The maximum gross return (Tk.134190 ha^{-1}) and gross margin (Tk.134190 ha^{-1}) were also obtained from BARI Chinabadam-8.

Farmers preferred BARI Chinabadam-8 for its higher yield, bigger nut size and higher market price. They also opined that disease infestation was less in BARI Chinabadam-8 compared to local one.

Performance of sesame varieties in high Barind Tract

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during kharif-1 season of 2015 to select suitable variety(s) of sesame for High Barind Tract. Four varieties viz. BARI Til-3, BARI Til-4, Binatil-1and local were tested in the farmer's field. Among the tested varieties, BARI Til-4 gave the highest seed yield (1.25 t ha^{-1}) followed by Binatil-1 (1.18 t ha^{-1}) and BARI Til-3(1.17 t ha^{-1}) and lowest in Local (0.88 t ha^{-1}). Farmers of High Barind Tract preferred BARI Til-4 for its higher yield.

Effect of different type of mustard variety in mustard-boro mixed cropping system

A field experiment was conducted at MLT site, Debidwer and Chandpur, Comilla during *rabi* season of 2015-16 to find out the suitable mustard variety in Mustard-Boro mixed cropping systems. Four different treatments i.e T_1=100% Boro rice (Var.BRRI dhan29) + 100% BARI Sarisha-9, T_2=100% Boro rice (Var.BRRI dhan29) + 100% BARI Sarisha-14, T_3 = 100% Boro rice (Var. BRRI dhan29) + 100% BARI Sarisha-15, T_4=100% Boro rice (Var.BRRI dhan29) + 100% BARI Sarisha-17 were used in the experiment. The highest Rice equivalent yield was recorded from T_4 (8.99 t ha^{-1}) that was followed by T_2 (8.78 t ha^{-1}) and T_3 (8.63 t ha^{-1}). Similar trend was followed in cost and return.

Mustard var. BARI Sarisha-17 and BARI Sarisha-14 produced higher yield than other mustard varieties in Mustard- Boro mixed cropping systems.

Regional yield trial of blackgram

The field trial was carried out at the farmer's field of MLT site, Amnura, Chapainawabganj during *kharif-II* season 2015 to select suitable variety through regional yield trial under drought prone area. Six genotypes/varieties of blackgram viz. BBLX-02005-1, BBLX-07002-5, BBLX-07002-1, BBLX-06002-10, 86337 and BARI Mash-3 were tested in the farmer's field. Among the tested genotypes/varieties BBLX-07002-5 gave the maximum seed yield (1.34 t ha^{-1}) followed by BARI Mash-3 (1.29 t ha^{-1}) and 86337 gave minimum seed yield (1.06 t ha^{-1}). Farmers were happy to get higher yield from the line BBLX-07002-5 followed by variety BARI Mash-3.

Adaptive trial of blackgram genotypes in high Barind Tract

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during *kharif-II* season 2015 to evaluate the high yielding blackgram genotypes in drought prone area. Seven genotypes/varieties of blackgram viz. BBLX-08010-2-1, BBLX-08010-4-1, BBLX-02005-1, BBLX-07002-5, BBLX-07002-1, BARI Mash-3 and a local variety were tested in the farmer's field. Among the tested genotypes/varieties, BARI Mash-3 gave the maximum seed yield (1.40 t ha^{-1}). Yield performance of advanced lines BBLX-07002-1(1.35 t ha^{-1}), BBLX-08010-4-1(1.36 t ha^{-1}) and BBLX-08010-2-1(1.33 t ha^{-1}) also produced higher yield and local variety gave minimum seed yield (0.99 t ha^{-1}). Farmers were happy to get higher yield from the variety of BARI Mash-3. Pest attack was lowest in the variety.

Participatory varietal selection of chickpea in high Barind Tract

A field trial was conducted in the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during *rabi* 2015-16 to develop variety through farmers' selection under Barind environment. Three advanced lines of chickpea viz. BCX-06004-10, BCX-06001-11 and ICCV 92944 and two varieties BARI Chola-5 and BARI Chola-9 were tested in the farmer's field. Among the tested entries, line ICCV 92944 and variety BARI Chola-9 gave the maximum seed yield 1.57 t ha^{-1} and 1.51 t ha^{-1}, respectively. The check variety BARI Chola-5 gave minimum yield (1.16 t ha^{-1}) followed by BCX-06004-10(1.21 t ha^{-1}). Considering the seed yield, line ICCV 92944 and variety BARI Chola-9 were found suitable for High Barind Tract soil.

Farmers obtained some promising cultivars for Barind condition e.g. ICCV 92944 and BARI chola-9. Farmers are happy to get higher yield from selected lines/variety. Pest attack was lowest in selected lines/variety.

Regional yield trial of chickpea in high Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Rajshahi during *rabi* 2015-16 to select suitable variety through regional yield trial under Barind environment. Five advanced varieties/lines of chickpea namely, BARI Chola-5, BCX-08009-9, BCX-08001-3, BCX-08008-1 and BARI Chola-9 were tested in the farmer's field of HBT. Among the tested entries BARI Chola-5 and BCX-08001-3 were taken the highest and lowest days for flowering, respectively and on the other hand, BARI Chola-5 and BARI Chola-9 were taken the highest and lowest days for maturity respectively. BARI Chola-9 gave the higher seed yield (1.64 t ha^{-1}) that is followed by BCX-08001-3 (1.51 t ha^{-1}). BCX-08009-9 (1.47 t ha^{-1}) and BCX-08008-1 (1.38 t ha^{-1}) were produced similar yield. The lowest yield (1.21 t ha^{-1}) was obtained from BARI Chola-5.

Farmers of the study area find out some genotypes like BARI Chola-9, BCX-08009-9 and BCX-08001-3 for their better performance as well as bolder size seed, higher number of pods $plant^{-1}$ and less pest infestation on the whole life cycle.

Adaptive trial of mungbean varieties in high Barind Tract

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during *kharif-1* season 2015 to select suitable variety through on-farm verification of mungbean varieties in High Barind Tract. Five varieties of mungbean viz. BARI Mung-3, BARI Mung-4, BARI Mung-5, BARI Mung-6 and BINA Mung-8 were tested in the farmer's field. Among the tested varieties BARI Mung-6 gave the maximum seed yield (1.40 t ha^{-1}) and BARI Mung-3 gave minimum seed yield (0.99 t ha^{-1}).

The performance of BARI Mung-6 was good in High Barind Tract and farmers preferred BARI Mung-6 for its better yield.

Effect of water stress at different growth stages on the yield of mustard

This experiment was conducted at BARI, Gazipur, and OFRD, Shympur, Rajshahi during the *rabi* season of 2015 - 2016 with BARI Sarisha-14. There were five irrigation treatments, each replicated thrice in a randomized complete block design. It was found that deficit irrigation (DI)utilized less seasonal water use to produce highest yield, water productivity, percentage water saved, and net return in compared to full irrigation. This irrigation reduced some plant growth (biomass and LAI) in compared to full irrigation. Seasonal water use and WP of 107.05 mm, 116.05 mm, 1.58 kg/m^3 and 1.23 kg/$m^3$was found by applying $DI_{80\%}$ up to FC at pre-flowering stage for Gazipur and Rajshahi. This treatment saved more than 50% water to produce 1.58 and 1.23 t ha^{-1} yield in both locations. This treatment also gave the highest net return of Tk. 1.94 lakh and 1.74 lakh ha^{-1} of land. From this study it can be said that cultivation of BARI Sarisha-14 at $DI_{80\%}$ at pre-flowering stage could give highest yield for water scarce region if sowing time soil moisture is at the available condition.

Performance of different soybean varieties in charland area under rainfed conditon

An experiment was conducted at the farmers' field of FSRD site, Kushumhati, Sherpur to observe the performance of soybean varieties during 2016 under AEZ-9. The highest seed yield (1.57 t ha^{-1}) was recorded from BARI Soybean-5 and lowest yield (1.40 t ha^{-1}) from Shohag variety. The farmers' preferred Soybean var. BARI Soybean-5 for its higher seed yield than Shohag.

Fertilizer management of lentil at char land area of Bhuapur, Tangail

An experiment was conducted under charland situation at the MLT site, Bhuapur, Tangail during *rabi* 2015-16 to find out the optimum fertilizer dose for BARI Mosur-6 under farmers' field condition. Five fertilizer packages viz T_1: 24-32-30-18-0.4 kg ha^{-1} NPKSB (Based on FRG, 2012 for HYG), T_2: 21-17-20-0-0 kg ha^{-1} NPKSB (based on PRC, BARI). T_3: 26-35-20-12-0.3 kg ha^{-1} NPKSB (Based on STB) T_4: Farmers practice (17-8-19-14-0) and T_5: controlwere considered as treatments. Among the treatments, T_3: 26-35-20-12-0.3 kg ha^{-1} NPKSB (soil test basis) gave the highest seed yield (1.56 t ha^{-1}) followed by T_2: 21-17-20-0-0 kg ha^{-1} NPKSB (PRC, BARI) (1.45 t ha^{-1}), T_4: 17-8-19-14-0 kg ha^{-1} NPKSB (Farmers practice) (1.37 t ha^{-1}) and lowest seed yield (0.94 t ha^{-1}) was obtained from T_5 treatment (control). The highest gross return (Tk. 108967 and 101733 ha^{-1}) and gross margin (Tk. 74045 and 70284 ha^{-1}) were higher in soil test based fertilizer dose and recommended fertilizer dose recommended by PRC, BARI. The lowest gross margin (37783 ha^{-1}) were found from the control plot.

Farmers opined that lentil var. BARI Mosur-6 following fertilizer dose 26-35-20-12-0.3 kg ha^{-1} NPKSB (soil test based) could be suitable dose for higher seed yield.

Validation of inter mixed cropping garden pea with onion

The experiment was conducted at MLT Site, Atghoria, OFRD, BARI, Pabna during the *rabi* season of 2015-16 to find out an economically profitable cultivation method of onion and garden pea. The experiment was consisted of four treatments viz. T_1= Sole onion, T_2=100% onion+60% pea with line sowing, T_3=100% onion+60% pea with broadcasting and T_4= Sole garden pea. Treatment T_2 (100%

onion+60% pea with line sowing) produced higher onion equivalent yield (10 t ha^{-1}). The highest gross return was also obtained from the same treatment (T_2) but higher gross margin (Tk. 141965 ha^{-1}) was obtained from sole onion (T_1).

Validation of planting technique of potato

An experiment was carried out in farmers' field at MLT site, Jhikargacha, OFRD, BARI, Jessore, Golapnagar char at MLT sites of Bheramara, OFRD, BARI, Kushtia and FSRD site, Kushumhati, Sherpur during *rabi* season of 2015-16 to validate the planting technique of potato in farmers' field. Four treatments viz. T_1= Recommended system of planting (60 cm x 30 cm), T_2= single eye planting (30 cm x 10 cm), T_3= single eye double row zigzag system (10 cm/30 cm x 10 cm) and T_4= half cut tuber (45 cm x 15 cm) were followed in the experiment. The highest tuber yield was obtained from recommended planting technique (T_1) in Jessore (21.46 t ha^{-1}) whereas 31.01 and 26.65 t ha^{-1} yield obtained from half cut tuber (T_4) in Kushtia and Sherpur, respectively.

Pest incidence: The crop was sprayed by applying Ridomil Gold, Dithane M-45, and Secure for controlling late blight of potato in Kushtia.

Though the highest tuber yield was obtained from recommended planting technique but farmers are interested to grow potato using half cut tuber planting technique in all the locations as it is more profitable than other planting technique.

Validation of chilli and hybrid maize intercropping under different planting systems in hilly areas

The experiment was conducted at OFRD, Bandarban during *rabi* season of 2015-16 to find out suitable intercropping systems of hybrid maize and chilli to study the effect of intercropping on component crops and increase total productivity and economic return. Two intercropping combinations viz., Single row of maize (100 cm x 25 cm) + 2 rows of chilli (50cm x 40cm) and Maize single row (150 cm x 25cm) + 3 rows of Chilli (50cm x 40cm) were evaluated against their sole crops. The highest cob yield of hybrid maize and green fruit yield of Chilli was obtained from sole crops. The highest gross return (Tk 239810 ha^{-1}), gross margin (Tk 164810 ha^{-1}) and benefit cost ratio (3.20) were recorded in maize single row (150 cm x 25cm) + 3 rows of Chilli (50cm x 40cm) combination. Single row of Maize (150 cm x 25cm) + 3 rows of Chilli (50cm x 40cm) combination might be suitable and economically profitable for the hilly areas.

Effect of raised bed planting and potassium application on the mitigation of soil salinity and yield of maize

A field experiment on hybrid maize (cv. BARI Hybrid Maize-9) was conducted in coastal saline soil at Kuakata, Patuakhali under Ganges Tidal Floodplain (AEZ 13) during late *rabi* 2014-15 and 2015-16 to test the possibility that salinity damage can be reduced by elevating K fertilization rate and to study the effects of planting method and K fertilization interactions on maize yield and nutrient uptake under salt stress condition. Four rates of fertilizer K (Native K, 100% STB K, 125% STB K and 150% STB K) were tested combining with two planting methods (Flat land and Raised bed) in a factorial randomized complete block design with three replications. Other nutrients were also applied following STB method. Prior to seed sowing the salinity level was low (EC: 2.6 dS m^{-1}). But the salinity level increased (2.16 and 12.46 dS m^{-1}) for flat land and raise bed, respectively with time during the growing period. The salinity intensity dropped in the second year due to off and on rain during the growing period, which reflected to have higher yield (7.09- 10.10 t ha^{-1}) as against 6.84- 9.17 t ha^{-1} in the first year irrespective of treatment. The higher rates of K contributed 23-29% increased yield over control as against 14% with STB dose, which implies the necessity of higher dose of K in salt affected soil in augmenting yield. Different combinations contributed 11-42% yield benefit over control. where raised bed with higher dose of K (K_4 x M_2) gave numerically better result over other combinations.

The contribution of raised bed in combination found 8.8%. Thus application of 25-50% higher rates of K over present STB dose under raised bed method of cultivation could be useful in minimizing salt stress and optimizing yield of hybrid maize in the study area.

Use of vermicompost for improving the growth and yield of cabbage

An experiment was conducted at On-Farm Research Division, BARI, Rangpur during the *rabi* season of 2015-16 to evaluate the effects of vermicompost on the growth and yield of cabbage. The experiment was laid out in RCB design with seven treatments viz; T_1 = 100% recommended chemical fertilizer (RCF), T_2 = 80% RCF, T_3 = 60% RCF, T_4= 100% RCF+ Vermicompost (VC) @ 1.5 t ha^{-1}, T_5= 80% RCF+ VC @ 3 t ha^{-1}, T_6 = 60% RCF+ VC @ 6 t ha^{-1} and T_7 = Absolute control. There were two harvesting time, i.e 67 days after planting (DAP) and 82 DAP and the highest head yield was recorded from T_4 in both harvest (60.77t ha^{-1}&72.61t ha^{-1}, respectively) where the lowest yield was obtained from T_7 (20.89 t ha^{-1}& 24.04 t ha^{-1} respectively). The highest crop growth rate was observed in T_4 (11.49 $gm^{-2}d^{-1}$) and the lowest in T_6 (4.97 g $m^{-2}d^{-1}$) where the total soluble solids were higher in T_7 treatment. The highest gross margin was calculated in T_4 (270060 Tk. ha^{-1}) and the lowest in T_7 (58978 Tk.ha^{-1}) at 82 DAP.

Adaptive trial with newly released potato varieties

The trial was conducted at farmers' field of Tangail, Rangpur, Khulna, Gopalganj, Bhola, Kushtia, Comilla, Patuakhali, Chittagong, Rajshahi, Mymensingh and Faridpur during *rabi* season of 2015 - 2016 to evaluate the performance of tuber yield of selected potato varieties/lines. Potato varieties viz. BARI Alu-7, BARI Alu-13 (Granola), BARI Alu-25, BARI Alu-28, BARI Alu-34, BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-38, BARI Alu-41 BARI Alu-42, BARI Alu-44, BARI Alu-45, BARI Alu-46, BARI Alu-47, BARI Alu-48, BARI Alu-49, BARI Alu-51, BARI Alu-52 BARI Alu-53, BARI Alu-55, BARI Alu-56, BARI Alu-59, BARI Alu-60, BARI Alu-61, 4.2.6.R, 5.183 were tested in different locations. Among the tested varieties BARI Alu-41(5.183), BARI Alu-46 and the line BARI Alu-52 performed better in most of the locations. Scab infestation was observed at most of the locations and its severity was high with the variety Diamant. Late blight disease was observed in some locations. Farmers' choice of potato varieties varied with locations mostly for yield performance, skin colour and market demand. According to farmers' choice BARI Alu- 41(5.183), BARI Alu-46, and BARI Alu-52 could be replaced by the popular variety Diamant.

Farmers' opinion

Tangail	Farmers preferred white skinned varieties specially BARI Alu-46 for its market demand and economic return.
Rangpur	Farmers preferred red skinned varieties for its market demand and economic return.
Khulna	Farmers preferred the variety 4.5W and Diamant for its higher yield, market price and demand.
Gopalganj	Farmers are happy with the yield potentiality of BARI varieties especially color and yield of BARI Alu-52
Bhola	The price of red skin potato is higher than white skin potato. Farmers preferred BARI Alu-42 (Agila), BARI Alu-44 (Elgar) and BARI Alu-45 (Steffi).
Puthia, Rajshahi	The co-operator farmers expressed their willingness to cultivate variety of BARI Alu-56, BARI Alu-48, BARI Alu-46 and BARI Alu-47.
Kushtia	Farmers preferred BARI Alu-41 as a new variety for its higher yield, its red skin color and higher market price.
Comilla	The price of red skin potato is higher than white skin potato. Farmers are happy with the yield potentiality of BARI varieties especially yield of BARI Alu-44 and BARI

	Alu-46
Patuakhali	Farmers showed their interest on BARI Alu-59, BARI Alu-41, and BARI Alu-51 compare to other varieties due to higher yield.
Faridpur	In spite of red color, BARI Alu-28 (Lady Rossetta) and BARI Alu-56 was not accepted because of round shape, medium size and comparatively lower yield but BARI Alu-44 (Alger), BARI Alu-46 (LB-7), BARI Alu-47 and BARI Alu-59 (Metro) were accepted by the farmers due to their whitish yellow colour.
Chittagong	Farmers showed their interest on BARI Alu -44, BARI Alu- 46 among the varieties due to higher yield.
Mymensingh	Farmers liked all the varieties having red and white skin but their selected varieties ranking order are: BARI Alu-46> BARI Alu-51> BARI Alu-56> BARI Alu-38> BARI Alu-59 > BARI Alu-34

Adaptive trials with improved varieties of mukhikachu

An experiment was carried out at Gaibandha, Sherpur, Comilla and Shyampur during 2015 to evaluate the yield performance of BARI released Mukhikachu variety (BARI Mukhikachu-1and BARI Mukhikachu-2) with local variety at farmer's field condition. Higher yield was recorded in BARI Mukhikachu-1 (25.69 tha^{-1}) at Gaibandha and BARI Mukhikachu-2 (30.31 t ha^{-1}) at Sherpur. In both locations local variety produced lower yield 18.28 t ha^{-1} and 19.1 t ha^{-1}, respectively. At Shyampur, the highest rhizome yield was obtained from Narikeli kachu (34.65 t ha^{-1}) followed by BARI Mukhikachu-2 (25.35 t ha^{-1}). Higher gross return and gross margin was recorded in BARI developed varieties at Gaibandha but the highest gross return, gross marginand BCR was obtained from local cultivar at Shyampur.

Pest Incidence

Rangpur: Thrips and jassid were observed in Aroid field and it was controlled with Imitaf @ 1ml L^{-1} water.

Farmers of Rangpur and Comilla preferred BARI Mukhikachu-1 over the local due to higher yield and economic return. Farmers of Sherpur were satisfied with BARI Mukhikachu-2 due to its higher yield but at Shyampur, Rajshahi local (Narikelikachu) produced higher yield and economic return.

Adaptive trial of BARI released panikachu varieties

An on-firm trial was conducted on six farmers' field at Rangpur, Jamalpur and Comilla to observe the performance of BARI released aroid varieties with the local cultivar. Three BARI varieties i.e, BARI Panikachu-2, BARI Panikachu-4, BARI Panikachu-5 and a local variety as check were used for the trial at Rangpur. Four BARI panikachu varieties viz., BARI Panikachu-2, BARI Panikachu-3, BARI Panikachu-4, BARI Panikachu-5 and a local variety as check were used for the trial at Jamalpur. At Comilla, four panikachu varieties viz., BARI Panikachu-1, BARI Panikachu-2, BARIheck Panikachu-3, BARI Panikachu-5 and a local variety were used as check. At Rangpur, BARI Panikachu-2 gave the highest stolon yield (19.18 tha^{-1}) and BARI Panikachu-4 (17.64 t ha^{-1}) produced the highest rhizome yield. At Jamalpur, the highest rhizome yield (42.25 t ha^{-1}) recorded from BARI Panikachu-4 but the highest stolon yield (24.51 t ha^{-1}) from BARI Panikachu-2. At Comilla, BARI Panikachu-1 and BARI Panikachu-3 produced the highest stolon yield and for stolon yield and rhizome purpose, BARI Panikachu-5 was the best. In all the locations, local variety produced the lowest yield.

Rangpur: Farmers were highly satisfied with BARI Panikachu-2 for higher yield as well as return.

Jamalpur: Farmers were highly satisfied with BARI Panikachu-4 for higher yield as well as return.

Comilla: Farmers were highly interested to grow BARI developed Panikachu varieties (BARI

Panikachu-1, BARI Panikachu-3and BARI Panikachu-5) due to its highest stolon yield and economic return.

Adaptive trial with advance wheat lines

An experiment was conducted at MLT site of Mirzapur, Tangail, OFRD, Comilla (on farm and on station) and RWRC, Rajshahi (on farm and on station) during the *rabi* 2015-16 in irrigated medium high land situation to evaluate the performance of some advance lines of wheat developed by BARI. It was laid out in RCB design with three replications. Three newly developed advance lines (BAW-1182, BAW-1200 and BAW-1202) along with a check variety BARI Gom-24 (Prodip) were considered. Among the tested lines, the highest grain yield was obtained from BAW-1202 in Tangail (3.86 t ha^{-1}) and Comilla on station trial (3.73 t ha^{-1}), BAW-1182 in Comilla on farm (3.21 t ha^{-1}) and Rajshahi on station (3.70 t ha^{-1}) and BAW-1200 (3.50 t ha^{-1}) in Rajshahi on farm trial. The lowest yield (2.82 to 3.23 t ha^{-1}) was obtained from the variety BARI Gom-24 (Prodip) in Tangail and Rajshahi (both on station and on farm) and BAW-1200 (2.50 to 3.13 t ha^{-1}) in Comilla.

Pest incidence: No pest infestation was occured during cropping season.

Tangail: Farmers showed their keen interest to the new advance lines due to their higher yield potentialities and less disease infestation, especially to BAW 1202.

Comilla: Farmers' preferred two advanced lines (BAW-1182 and BAW-1202) for their higher yield potential, bold size and shorter crop duration compared to commercially cultivated wheat variety Prodip.

Rajshahi: Farmers showed their interest to the new advance lines.

Screening wheat against salinity under field condition

A screening trial with different lines/varieties of wheat was conducted at Kuakata, Kalapara, Patuakhali during *rabi* season of 2015-1. Fourteen wheat genotypes i.e. BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29, BARI Gom 30, BAW 1135, BAW 1157, BAW 1170, BAW 1177, BAW 1182, BAW 1193, BAW 1200, BAW 1202 were planted to screen out their performance in southern saline area. Salinity of the trail plots increased with time and it ranged 2.5 to10.3 in the whole growing period. Among the varieties/lines BARI Gom-25 produced the highest yield (2.20 t ha^{-1}). BARI Gom-30 gave the lowest yield (1.10 t ha^{-1}). Among the lines BAW 1182 produced the highest yield (1.6 t ha^{-1}).

Adaptive trial of BARI summer onion variety

An on farm trial was conducted in MLT site Gobindaganj, Gaibandha to evaluate the field performance of BARI released summer onion varieties during *kharif* season of 2015. BARI released summer onion varieties BARI PIaj-2, BARI Piaj-3 and BARI Piaj-5 were tested at farmer's field condition. The highest yield was found in BARI Piaj-5(12.10 t ha^{-1}) and lowest was in BARI Piaj-3(10.27 t ha^{-1}). The highest gross margin was recorded in BARI Piaj-5 (Tk.293965 ha^{-1}) and lowest was recorded in BARI Piaj-3 (Tk.239065 ha^{-1}).

Pest incidence

Tip burn disease was observed in some plots and the disease was controlled by spraying of Rovral (0.02%) two times and Imitaf was applied two times @ 0.5 ml L^{-1} to control thrips.

Farmers showed keen interest on onion var. BARI Piaj-5 exhibited higher yield and gross margin over the BARI piaj-2 and BARI Piaj-3.

On-Farm trial of coriander at charland

An experiment was conducted at the char land of Bhuapur, Tangail and MLT site, Gobindaganj, Gaibandha during the *rabi* season of 2015-16 to evaluate the performance of BARI Dhonia-1 under farmer's field condition and to popularize it among the farmers. Higher yield 1.39 t ha^{-1} and 1.92 t ha^{-1} was obtained from BARI Dhonia-1 at Tangail and Gaibandha, respectively over the local check 0.778 t ha^{-1} and 1.45 t ha^{-1}.

Pest incidence: There was no remarkable disease and pest infestation in coriander crop field in Rangpur.

Tangail: Farmers are interested to grow BARI Dhonia-1 for its higher yield potentiality.

Rangpur: The local farmers of Gobindaganj observed that the growth of BARI Dhonia-1 was vigorous and it gave be higher yield. As fresh leaf, it can be used in the curry for aroma than local variety.

On-Farm trial of black cumin at charland

An experiment was conducted at the char land situation of Bhuapur, Tangail and MLT site, Gobindaganj, Gaibandha during the *rabi* season of 2015-16 to evaluate the performance of BARI Kalojira-1 under farmer's field condition and to popularize it among the farmers. Higher yield 975 kg ha^{-1} and 1083 kg ha^{-1} was obtained from BARI Kalojira-1 at Tangail and Gaibandha over local check 718 kg ha^{-1} and 901 kg ha^{-1}, respectively. In both locations higher gross margin was recorded in BARI Kalojira-1.

Pest incidence: Aphid was controlled by Imitaf @ 1mlL^{-1} in Rangpur

Farmer's opinion: Black cumin was a new crop at the char land of Bhuapur. Farmers opined that they were interested to grow BARI Kalozira-1 for its higher yield potentiality. They want to get available seeds of BARI Kalozira-1 during growing season. In Rangpur, Farmer's preferred BARI Kalozira-1 due to its higher yield and higher gross margin.

On-Farm Trial of Fenugreek At Charland

An experiment was conducted at the charland of Bhuapur, Tangail during the *rabi* season of 2015-16 to evaluate the performance of BARI Methi-1, BARI Methi-2 against a local one under farmer's field condition and to popularize them among the farmers. The highest yield 1.47 t ha^{-1} and 1.93 t ha^{-1} was obtained from BARI Methi-2 at Tangail and Gaibandha, respectively over local check 1.64 kg ha^{-1} at Gaibandha. In both locations higher gross margin was recorded in BARI Methi-2.

Farmers were impressed with high yield and gross margin from BARI Methi-2 as yield and return from local variety is relatively lower than BARI released varieties.

Adaptive Trial of Radish Varieties

On-farm adaptive trial was conducted at farmers' field at Kumarkhali upazila under Kustia district during *rabi*, 2014-15 to 2015-16 to evaluate the performance of radish varieties in farmer's field. Three BARI released varieties (BARI Mula-1, BARI Mula-2 and BARI Mula-4) and one local as check were tested. Among the varieties, BARI Mula-1 gave the highest yield (46.96 t ha^{-1}) and maximum economic return (gross margin: Tk. 338498 ha^{-1}) than local variety (30.00 t ha^{-1}) and gross margin Tk. 253588 ha^{-1}.

Farmers preferred BARI Mula varieties due to its higher yield and higher market price. They also had chosen BARI Mula-2 for its colour, taste and highest market price among the tested varieties.

On-Farm trial of BARI developed gladiolus varieties

An on station trial on BARI Gladiolus varieties was set up at On-farm research division, Rangpur during Rabi season of 2015-16. Four BARI Gladiolus varieties were tested Viz. BARI Gladiolus-1, BARI Gladiolus-3, BARI Gladiolus-4 and BARI Gladiolus-5. Among the varieties BARI Gladiolus-5 performed excellent in terms of spike production and market value. The highest gross margin (Tk.

79558 ha^{-1}) was recorded in BARI Gladiolus-5. The lowest gross return as well as gross margin (Tk. 93284 ha^{-1}) was obtained from yield BARI Gladiolus-1.

Integrated Farming

Integrated farming for improving livelihood of resource-poor farm households in a participatory approach

In integrated farming studies, effort is being made to improve whole farm system operation to maximize farm productivity, farm resource use efficiency, employment opportunity, farmers' income and nutrition as well as livelihood of the resource poor farm households. Resource poor farm households are now in concern with the increasing of human population and decreasing of agricultural land and thus, it needs to manage properly all the resources of a farm household in integrated approach. The integrated farming activities were carried out in 9 sites at Plain land ecosystem-northern and eastern zone (FSRD site Lahirirhat, Rangpur; Pushpopara, Pabna; Elenga, Tangail; Hatgobindapur, Faridpur and Kusumhati, Sherpur) and Coastal and Rainfed ecosystem (FSRD site Kadamshahar, Barind, Rajshahi; Jalalpur, Sylhet; Rajakhali, Patuakhali and Hazirhat, Noakhali) during 2015-16. The research areas were i) Homestead production system ii) Crops and cropping system iii) Poultry and livestock production system, iv) Fisheries production system and v) Off-farm activities. All components of integrated farming such as vegetables, fruits, cereal crops, livestock, fish and off-farm activities were brought under improved technological intervention and accordingly income were increased from these components. **In plain land ecosystem (northern & eastern zone),** the overall results of those experiments showed that farmers obtained higher yield and economic return from their alternate or improved cropping pattern with improve variety(s). Four/three improved cropping pattern trials were conducted in different location of which Wheat-Jute-T.Aman gave the highest productivity and economic return (Gross margin Tk. 227090 ha^{-1}). Newly released high yielding crop varieties were also introduced through on farm validation program where farmers obtained higher crop yields and gross margin (Tk. 12550-289050 Tk ha^{-1}). Results of homestead production program revealed that intake of vegetables were markedly increased (avg. 276%) by all families included in this system. Average intake of fruits per year was also increased (Avg. 107%) after intervention of the technology. Existing fruit tree management and new plantation has created a good impact on farm households. Gross return (avg. 203%) and gross margin (avg. 242%) was increased due to deworming and vaccinaton program of cattle. Mortality of poultry reduced (75-95%) after vaccination. Moreover, farm yard manure (FYM) production and utilization were created a good impact among the farm families. Green fodder (Napier grass) production was found profitable (gross margin Tk. 169150 ha^{-1}) and suitable for the farm families. Among the seasonal fish culture carp polyculture gave higher gross margin (Avg. Tk. 17061 $pond^{-1}$) at farmers' level. From off-farm activities, farmers also earned some extra money (Avg. Tk. 8967 $household^{-1}$). **In coastal and rainfed ecosystem (southern an northen zone),** newly released high yielding crop varieties were also introduced through on farm validation program where farmers obtained higher crop yields and gross margin (Tk. 31350-739080 ha^{-1}). Six improved cropping pattern trials were conducted in different location of which Potato-Mungbean-T.Aman gave the highest productivity and economic return (Gross margin Tk 446735 ha^{-1}) at Patuakhali. Vegetables production was increased maximum at Razakhali, Patuakhali (456%) and minimum at Hazirhat, Noakhali (157%) compared to before intervention of the program. Result of this intervention was very encouraging as intake of vegetables by all types of farm families increased (Avg. 207%) remarkably. Average intake of fruits per year was also increased (Avg. 189%) after intervention of the technology. Women participation in agricultural activities increased to a great extent that showed some positive effect on gender equity within the family. After deworming and vaccination against major diseases i.e. Anthrax, Foot and Mouth Disease and Black Quarter reduced disease frequency and mortality rate of cattle which contributed higher production and gross margin increased in average 136%. Poultry rearing in the homestead area created a good impact among the farm families as a good source of income. In fisheries production system, it was found that farmers sold most (Avg. 145%), consumed about 56% and distributed 9% among their neighbours, relatives and well-wishers of the produced fish. Average gross margin obtained per pond about Tk. 15852. Finally, it can be concluded that interventions made in different components exerted a visible positive impact in improving farmers' socio-economic condition and livelihood as well. The daily nutritional requirements of the family members were supplemented considerably due to increased of consumption of vegetables and fruits from the homestead gardening and also from fish, chicken and livestock production. Active participation of the farmers' and integration of their available resources in planned way has created a positive impact on improving livelihood of resource poor farm household. The results of FSRD activties imply that by implementing the coordinated approach of farming systems at FSRD sites has brought a good impact on the resource-poor farmers for the betterment of livelihood.

Impact

- By regularly monitoring the performance, farmers become aware of achievements as well as deficiencies, and by paying attention to detail they can continuously work on improving the whole farming enterprise and their economic performance at the same time.
- Farmers gathered knowledge about component basis innovative technologies due to which they grow their awareness about integrated farming systems activities for better maintenance of their life.
- Women are specially participated in homestead based activities like vegetable production, taking care of fruit trees, poultry rearing, cattle rearing and composting because they have trained up about the relevant technologies.
- Recently, school girls and children are included in the homestead activities especially vegetable gardening and poultry rearing.
- Farmers have already motivated to implement integrated holistic approach because the obtained cash income from different enterprises as well as household component.

Utilization of fisheries *gher* boundaries through cultivationof vegetable crops in Bagerhat

The experiment was conducted at the MLT site, Bagerhat during 2015-'16 to find out the suitable vegetable pattern for cultivation in the boundaries around fisheries gher for the optimum economic return. Five patterns of vegetables for broad boundary (breadth >1m) and three patterns for narrow boundary (breadth <1m) were designed for conducting the experiment. A satisfactory yield was obtained from both kharif and rabi vegetables grown in gher boundary at Bagerhat. Among three *rabi* vegetables, the highest gross margin (Tk. 250500 ha^{-1}) was recorded from tomato and the lowest gross margin from knolkhol (Tk. 73475 ha^{-1}). In kharif season, the highest gross margin (Tk. 188850 ha^{-1}) was recorded from bitter gourd while the lowest gross margin was found in okra (Tk. 21175 ha^{-1}).

Instead of sole fish cultivation, they are very much interested to cultivate vegetables as insurance crop simultaneously. Farmers are interested to cultivate tomato in *rabi* season due to its higher gross margin and satisfactory market price. In *kharif* season, they are interested to cultivate bitter gourd due to its higher gross margin and satisfactory market price.

Table Vegetable crops as pattern for *gher* boundary at MLT site, Bagerhat, 2015-16

Kharif		*Rabi*	
Vegetable crops	Date of sowing/ transplanting	Vegetable crops	Date of sowing/ transplanting
Okra	25 May, 2015	Tomato	3-13 November, 2015
Cucumber	10-25 May, 2015	Knolkhol	3-13 November, 2015
Bitter gourd	10-25 May, 2015	Bottle gourd	19-25 August, 2015

Socioeconomic Studies

Impact of hybrid rice and maize seed in cereal production system in Bangladesh

The study was undertaken on production and marketing scenario, farmers' perception and efficiency of hybrid rice and maize producers in Bangladesh. Data from 400 farmers and 40 seed dealers were collected from Dinajpur, Sherpur, Gopalganj and Noakhali district. Ten leading seed companies were also included in the study. About 4 thousand tons of hybrid rice seed were imported by leading 10 seed companies in 2014-15 which was about 38% of total import of hybrid rice seed. BADC is the main hybrid seed producer (HL 8 h) in Bangladesh but it is not more than 10% of total import. Twelve to twenty-seven hybrid rice varieties were found in the study districts, and the highest area covered by hybrid in Gopalganj Sadar (13813 ha) followed by Sonaimuri (7200 ha) of Noakhali. Farmer's gross return and gross margin increased by using hybrid rice seed. The solution of the linear programming model shows that area under HYV rice have been shifted to hybrid rice about 8 to 52 percent. The results of stochastic frontier production model indicated that inefficiency effects are present in hybrid rice and maize production. Hence, technical inefficiency effects have significant impact on output. These results suggest that there is a substantial scope for increasing rice production in the country using hybrid seed. Farmers are happy by producing hybrid rice as it is higher yielder.

Input use and profitability of crops under major cropping patterns in Tangail district

The study was conducted at the FSRD site, Elenga, Tangail during April-May, 2016 to document the input use level and to estimate the profitability of crops under major cropping patterns. A total of 60 sample farmers were selected to collect necessary primary data with the help of pre-designed survey schedule, group discussion and face to face interview method. Purposive sampling technique was followed for selecting the sample farmers. Data were collected from three major cropping patterns such as Wheat-Jute-T.aman, Mustard-Boro-T.aman and Boro-Fallow-T.aman. The study revealed that considering the Wheat-Jute-T.aman cropping pattern, the total production cost, gross return, net return and BCR were calculated Tk. 200987, Tk. 342680, Tk. 141694, and 1.68, respectively. In Mustard-Boro-T.aman cropping pattern, the total production cost, gross return, net return and BCR were found Tk. 196517, Tk. 250900, Tk. 54383 and 1.42 respectively. In Boro-Fallow-T.aman cropping pattern, the total production cost, gross return, net return and BCR were estimated Tk. 159819, Tk.182500, Tk. 182500 and 1.16, respectively in the study area. The study revealed that farmers used lower dose of fertilizer in most of the crops in the major cropping patterns except TSP in Wheat under Wheat-Jute-T.aman, Urea and TSP in Mustard under Mustard-Boro-T.aman cropping pattern. Most of the farmers did not use manure and follow the recommended dose of fertilizer in their crops. So training on production technology and fertilizer management should be arranged to enhance production by minimizing production cost of the crops. Government should increase selling price of output for giving inspiration to crop production as well as better living of the farmers.

Socioeconomic study on cauliflower production in some selected areas of Bangladesh

Vegetables sub-sector plays an important role for development of Bangladesh. Vegetables are an herbaceous plant whose fruits, seeds, roots, tubers, leaves etc., are used as food. Vegetable is important for nutrition, economy and food security. Farmers are producing cauliflower in different planting time (such as, early, optimum and late) for getting higher benefit. The up-to-date information regarding financial profitability of this crop is unknown to the researchers and policymakers. Therefore, the study was conducted in Bheramara and Gangni upazilas to estimate profitability of cauliflower production and to find out constraints to its production during 2015-2016. The cultivation of cauliflower was profitable to the farmers since per hectare total cost, gross return and net return of cauliflower. Cauliflower is more profitable compared to its competitive crops like all rice and jute. Lack of good quality seed and variety, severe attack of pests, high price and adulterate of used seed, lack of training, high price and adulterate of pesticides and lack of knowledge about improved management practices.

15 PLANT PATHOLOGY

Fungal Disease

Prevalence of fungi associated with maize grain

Seed- borne infection of maize (*Zea mays* L.) by fungal pathogens was studied using 16 grain samples of maize collected from different locations of Rangpur, Lalmonirhat, Thakurgaon, Comilla, Pabna, Natore and Kushtia districts of Bangladesh during 2015-16 cropping season. The moist blotter test was used to detect fungi on maize grains. Six fungi were recorded on maize grain samples and they were *Aspergillus flavus* (ranging from 4 to 58*%),* *Aspergillus niger* (8 to 86%), *Fusarium* sp (2 to 74%), *Penicillium* sp (4 to 48%), *Rhizopus stolonifer* (2 to 50%) *and* *Bipolaris* sp (only 2%). Among them the most predominant fungi was *Aspergillus niger* which was 86% found in grain sample collected from Allar Dorga, Kushtia. *Fusarium* was in second position with 74% incidence from the grain sample of Tebunia, Pabna location and *Aspergillus flavus* was in third position in accordance of its incidence which was 58% in grain sample collected from Dasuria, Pabna. The least incidence was found in case of *Bipolaris* sp which was only 2% from the collected grain samples of Daudkandi-Comilla, Takurgaon and Nilokchondi, Rangpur locations.

Assessment of seed borne pathogen of sesame in Bangladesh

A total of thirty six seed samples of sesame saved by the farmers were collected from different locations of Jamalpur, Mymensingh, Netrakona, Natore and Pabna distric of Bangladesh and used for testing their health status. *Fusarium* sp, *Aspergilus flavus*, *Aspergilus niger* ,*Epicochum*, *Rhizopus* , *Alternaria* sp, *Penicillium*, *Botrytis* sp, *Curvularia* comprising 9 sp. or genera were found to be associated with the sesame seed samples. Among them the most predominant was *Aspergilus flavus* which is associated with 41.6 % seed samples followed by *Aspergilus niger* (14.4)and unknown organizum (37.6). A few incidence of *Epicochum* 0.8 % was observed. The highest (98%) percent of germination was recorded from the sample collected from Mymensingh sadar followed by Pabna and Natore districts while the lowest germination was recorded from sample of Purbodala upazila of Netrakona district.

Study on the seed borne pathogens of some selected vegetables

The study was carried out to find out the pathogens associated with seeds of 8 different vegetables crops collected from Sherpur and Jamalpur districts of Bangladesh. Ten species of fungi viz. *Alternaria alternata*, *Aspergillus flavus*, *Aspergillus niger*, *Botryodiplodia* sp., *Bipolari*s sp., *Cladosporium* sp., *Colletotrichum* sp., *Curvularia lunata*, *Fusarium* sp. and *Penicillium* sp. were detected from the seeds of selected vegetables. Among the indentified fungi, *Alternaria alternata*, *Botryodiplodia* sp., *Pennicillium* sp., *Cladosporium* sp. and *Fusarium* sp. were predominant.

Optimization of mycelial concentration of *Stemphylium botryosum* in developing stemphylium blight disease in lentil

An experiment was conducted to optimize mycelial concentration of *Stemphylium botryosum* for effective disease development in artificially inoculated lentil plants. Five concentrations viz. 0.5, 1.0, 1.5, 2.0 and 2.5 g of mycelia/L of water was used in this study. Inoculating plants with a suspension of

2.5 g of mycelia L^{-1} resulted highest (~80%) level in disease severity after 12 days of inoculation. Increasing the mycelial concentration from 0.5 g of mycelia L^{-1} increased severity gradually upto 2.5 g of mycelia L^{-1}. Lowest (14%) disease severity was observed after 15 days of inoculation when inoculating plants with a suspension of 0.5 g of mycelia L^{-1}.

Development and standardization of a protocol for molecular detection of fungal pathogens for plant pathology laboratory, BARI

An experiment was conducted to develop and standardize molecular detection technique of fungi through internal transcribed spacer (ITS) sequencing for Plant Pathology Laboratory, BARI. Four new isolates of fungi were characterized through polymerase chain reaction (PCR) amplification followed by ITS sequencing. All the DNA samples of the isolates were amplified properly and those were clearly verified by agarose gel electrophoresis. Amplified DNA was sequenced, analyzed and constructed phylogenetic trees with respective sequences. Based on nucleotide sequences two isolates were confirmed as *Sclerotinia sclerotiorum* for white mold pathogen. Another isolates was identified as Nalanthamala psidii for guava wilt pathogen that considered as a new record in Bangladesh.

Screening of tomato lines/varities against early blight disease under natural field condition

An experiment was conducted in the research field of Plant Pathology Division, BARI during 2015-16 cropping season to evaluate the performance of twenty four tomato lines against early blight disease. Seventeen lines and seven varieties of tomato were used. Two tomato lines namely GPT- 009 and GPT- 0011 showed highly resistant reaction against the disease. Among the others, five lines showed resistant and twelve lines/varieties showed moderately resistant type of reaction.

Screening of lentil lines against stemphylium blight disease under inoculated condition

The experiment was conducted at BARI, Gazipur. A set of 18 lentil entries were evaluated against stemphylium blight disease in this experiment. The Eighteen lentil test entries were BD-3807, BD-3943, BD-4053, BD-4 I34, LRIL-21-36, LRIL-22-36, LRIL-22-198 and LRIL-21-5888, BLX-06004-2, BLX-04004-3, BLX- 01013-1, BLX-04005-9, BLX-07004-7, BLX-06004-12, BLX-05002-3, BLX-07003-6, ILL-5134 and LR-9-25 which was selected from the previous years' trial. A susceptible check variety BARI Masur-1 was used. Lowest (1.33) stemphylium blight disease score and highest (1233 kg/ha) yield was recorded in LR-9-25 and the highest (5.00) disease score with lowest (728.70 kg/ha) yield was recorded in the check variety BARI masur-1.

Screening of rapeseed-mustard lines for resistance to *orobanche*

An experiment was laid out at Regional Agricultural Research Station, Ishurdi, Pabna during 2015-16 to observe the magnitude of resistance of 31 oilsseed Brassica germplasms namely BJ-1111536-5-9, BJ-1111536(12)-1, BJ-1111536(12)-6, BARI-11, BJ-1111536(9)-2, BJ-1111536-12-5, BJ-1111536-12-3, BJ-1111536(11)-1, BJ-10411(Y), BARI-Sharisa16, Nap-205, Nap-0717-2, Nap-0660, Nap-08-4, Nap-0837, Nap-0762, Nap-0885, Nap-0865, Nap-0876, Nap-0733-1, BC-100614-8-4, BC-110614-7-6, BC-110714(9)-5, BC-100614(4)-12, BC-100614(4)-7, BC-100614-4-19, BC-100614-8-2, BC-100614-4-17, BC-100614-4-2, BC-100614(4)-5 and Tori-7 against Orobanche. Among the evaluated germplasms, nine lines/varieties viz. BARI-11, BARI-16, BC-110614-7-6, BC-110714(9)-5, BC-100614(4)-12, BC-100614(4)-7, BC-100614-4-19, BC-100614-4-2 and BC-100614(4)-5 showed resistant reaction, 5 lines showed moderately resistant reaction and the rest of 17 lines including check showed susceptible reaction against Orobanche.

Screening of potato germplasm against late blight disease

A total of twenty three (23) lines of potato including two resistant check varieties BARI Alu 46 and BARI Alu 53 and two susceptible check varieties Diamant and Granola were evaluated under natural epiphytotic condition against late blight disease. All the test lines were found susceptible against late blight. But the two resistant check varieties BARI Alu 46 and BARI Alu 53 were found resistant.

Screening of groundnut germplasm against white mould disease under natural field condition

An experiment was conducted at Regional Agricultural Research Station, Jamalpur during 2015-2016 to find out resistant lines of groundnut against white mold diseases. Thirty different lines/varieties were evaluated and compared with two varieties Zingha badam and Dhaka 1. Among the thirty materials only four lines K-2, 06285, 07219 and 96175 were showed resistant reaction against the disease.

Efficacy of new fungicides in controlling botrytis blight of marigold

An experiment was conducted in the field of Plant Pathology Division, BARI, Joydebpur, Gazipur to evaluate the efficacy of new fungicides in controlling botrytis blight disease of marigold during rabi 2015-2016 cropping season. The design was RCB with 3 replications. Hybrid Inka variety was used for this study. There were six treatments namely Cibazol 32.5 SC, Tilt 250 EC, Secure 600 WG, Agrolux 72 WP, Achal 80 WP and control (no fungicide). Four sprays were done at 12 days intervals. Among the tested fungicides the lowest diseases severity 13.48% (PDI) was found in Tilt 250 EC and 15.30% in Secure 600 WG treated plots.

Effect of some new fungicides in controlling leaf blight of wheat

An experiment was conducted in the field of Plant Pathology division of BARI with eight fungicides namely, Win 25 EC, Amister, Tiptop 30 EC, Pridizole, Azomex, Velki, Probhat, to control the leaf blight (*Bipolaris sorokiniana*) of wheat during 2015-2016 cropping season. From the experiment it was found that all the fungicides potentially decreased the disease and increase the yield compared to control. Among the tested fungicides, the lowest diseases severity (PDI) and highest yield were found in Win 25 EC sprayed plot followed by Probhat sprayed plot. .

Standardization of spray schedule of two effective fungicides against stemphylium blight disease of lentil

The experiment was carried out to evaluate Rovral and Secure with different combinations to reduce the protection cost against stemphylium blight disease of lentil. The investigation was designed in RCB with three replications. In three locations the minimum disease score (1.0) was recorded from Rovral alone treated plot which was statistically similar to alternate spray of Rovral and Secure and Rovral: Secure (1:1) treated plots. The highest (5.00) disease score was observed in control plot. Among the four treatment combinations the highest number of pods plant^{-1} (65.33) and highest grain yield (1432.00 kg ha^{-1}) was obtained from the plots alternately sprayed with Rovral and Secure which is statistically similar to the plots sprayed with Rovral alone. The lowest number of pods plant^{-1} (34.33) and grain yield (751.00 kg ha^{-1}) was obtained from the control plot. The highest net return (Tk. 28260 ha^{-1}) and MBCR (2.24) was recordedfrom the plot alternately sprayed with rovral and secure.

Efficacy of new fungicides in controlling purple blotch disease of onion

An experiment was conducted in the field of Plant Pathology, Division, BARI during 2015-16 cropping season to find out the effectiveness of 14 new fungicides against purple blotch of onion. Among the fungicides higher disease reduction were recorded by Syntwvo 75 WG, Nobin 75 WG, Cymox 72 WP, Ricovo 75 WG, Robin 50 WP, Mim 52.5 and Mela 50 WP. The lowest (14.87%) and the highest (75.12%) disease incidence were recorded from Rovral+Ridomil gold and control treatment, respectively.

Efficacy of different chemical fungicides on alternaria leaf spot of broccoli

The experiment was conducted at Regional Agriculture Research Station, Jessore during 2015–2016 to find out the effective fungicides in controlling alternaria leaf spot of broccoli. Amister Top performed the lowest disease severity (1.33) followed by Rovral and Iprozim treated plots. The highest yield (10.72 t/ha) was found in Amistar Top treated plot which was statistically similar to Rovral and Iprozim treated plots (10.61 t/ha and 10.02 t/ha), respectively. On the other hand, the lowest yield (4.66 t/ha) was found in T_8 (control) plot.

Study of fungicides against white mold disease of mustard

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during rabi season 2015-2016 to find out the effective fungicides for controlling white mould / sclerotinia rot disease of mustard. Seven fungicides viz. Rovral 50 WP, Score 250 EC, Folicur 250 EC, Indofil M 45, Contaf 5 EC, Secure 600 wg and Tilt 250EC were tested for their performance against the disease. All the fungicides showed significantly better performance over control. The lowest incidence of white mould disease (0.95%) was found in Folicur 250 EC (2ml/l) treated plots whereas the highest (11.62%) was recorded in control plots. Moreover, Folicur 250 EC (2ml/l) treated plots has provided the highest yield (1.51t/ha).

Effect of new fungicides in controlling sigatoka/ leaf spot disease of banana

The experiment was conducted at RARS, Ishurdi, Pabna during 2015-16 to find out effective new fungicides to control sigatoka/leaf spot disease of banana. Eleven new fungicides viz. Luster (Fusilazole+Carbendazim), Forsol 50 WP (Carbendazim), Lataf 10 EC (Hexaconazole), Forstobin 25SC (Azosystrobin), Defence 5EC (Hexaconazole), Nobin 75WG (Trifloxostrobin+Tebuconazole), Green Win 50 (Carbendazim), Bravo (Tebuconazole+ Azosystrobin), Tornado Ford 75 WG (Trifloxostrobin+Tebuconazole), Topas 75 WG (Tebuconazole+ Trifloxostrobin), Helmet (Benomyl) and Control were used in this experiment. All fungicides except Helmet (Benomyl) successfully reduced more than 60% sigatoka/leaf spot disease incidence of banana. The disease reduction over control ranged from 58.51- 67.40%. The highest disease reduction over control was recorded in Bravo (Tebuconazole+ Azosystrobin) @ 1ml/l with 67.40% and the lowest was recorded in Helmet (Benomyl) @ 2g/l with 58.51%.

Effect of new fungicides in controlling powdery mildew disease of cucurbit

The experiment was conducted at seed production field of sweet gourd at HRC, RARS, Ishurdi, Pabna during Kharif season 2015 to find out effective new fungicides to control powdery mildew disease of cucurbits. Ten new fungicides viz. Headtene Team (Pyraclostrobin+Dinathomorph), Zampro DM (Ametoctradin+ Dinathomorph), Prozim 50 WP (Carbendazim), Medumyl 72 WP (Mancozeb+Metalaxyl), Maghmani 80 WDG (Sulphur), Lataf 10 EC (Hexaconazole), Nobin 28 SC (Azoxystrobin+Cyproconazole), Alvit 80 WDG (Sulphur), Forstrobin 25 SC (Azoxystrobin), Release 72 WP (Mancozeb+Cymosanil) and Control. The disease reduction over control ranged from 12.49% to 73.75%. The highest disease reduction over control was recorded in Nobin 28 SC @ 1ml/l sprayed plots with 73.75% and the lowest was recorded in Prozim 50 WP @ 2g/l sprayed plots with 12.49%. Fungicides Headtene Team, Nobin 28 SC and Alvit 80 WDG successfully reduced more than 60% powdery mildew disease incidence of sweet gourd.

Effect of different economic spray schedule of mancozeb in controlling late blight of potato on resistant and susceptible variety

The trial was conducted during the rabi season of 2015 – 2016 at Regional Agricultural Research Station, Burirhat, Rangpur to determine the spray schedule of Mancozeb in controlling late blight of susceptible and resistant varieties of potato. There were two resistant varieties namely BARI Alu-46 and BARI Alu-53 and a susceptible variety Diamant. Four spray schedule of Mancozeb (Dithane M 45@ 0.2%) were one time spray; two times spray; three times spray and four times spray. One unsprayed plot was maintained for each variety. Among the varieties significantly the lower disease were observed in the two resistant varieties than the susceptible variety. In the combined effect it was observed that the highest yield 53.47t/ha was obtained from the resistant variety BARI Alu-46. The yield of other resistant variety (BARI Alu-53) was also significantly higher than the susceptible variety Diamant. In the interaction of variety and spray schedule it is observed that all varieties the yield was increased as the number of spray was increased. However the highest yield (59.38t/ha) was obtained from BARI Alu 46 with 4 spray which was statistically at per with 3 spray (58.89t/ha).

Effect of new fungicides in controlling late blight disease of potato

A field trial was conducted to evaluate the efficacy of some chemical fungicides for the control of potato late blight disease during the rabi season of 2015 – 2016 at Regional Agricultural Research Station, Burirhat, Rangpur. Fifteen (15) new chemical fungicides along with two recommended fungicides were evaluated at predetermined doses. Considering the disease severity all the fungicides were found effective against late blight as compared to unsprayed control. The disease severity of unsprayed plots at 70 Days after planting (DAP) was 100%. But in case of the most effective fungicides the severity was within the range of 2.66% - 10.00%. The highest yield of 48.49 t/ha was obtained with the fungicide Reba although the disease severity was 10.00%.

Efficacy of fungicides to control major diseases of garden pea

An experiment was conducted at RARS, Burirhat, Rangpur during 2015-16 to find out suitable fungicide(s) for controlling major diseases of garden pea. Six different fungicides viz. Tilt 250 EC, Contaf 5 EC, Folicur EW 250, Bavistin DF, Rovral 50 WP and Dithane M-45 were tested against the diseases along with control. Among the fungicides Folicur was found effective in controlling rust of garden pea where severity was 13.33% followed by Contaf (17.33%) and Tilt (19%). In case of Sclerotinia rot incidence Rovral was found effective where severity was 22.04% which was statistically similar to Folicur (23.01%). Other fungicides were also effective against the diseases compared with control. Sclerotinia rot severity was statistically similar in all the fungicides. Maximum garden pea yield (2.23 t/ha) was obtained from Folicur followed by Contaf (1.67 t/ha), Tilt (1.62 t/ha) and minimum yield (1.15 t/ha) was obtained from untreated control plots.

Efficacy of fungicides in controlling white mould disease of bean

Effect of five different fungicides on disease incidence of white mold and yield of bean were studied at RARS Jamalpur during rabi season, 2015-2016. All the chemical treatments had significant effect on reduction of disease incidence as well as positive impact on yield of the crop compared to control. Considering the disease incidence and yield of bean, secure and rovral were found better than others for controlling white mold of bean.

Management of sooty mold of mango

The experiment was conducted in the established mango orchard of Regional Agricultural Research Station, Hathazari, Chittagong during 2014-15. Five treatments viz.Thiovit, Copper Oxycloride, Imidacloprid, Cypermethrin with Propiconazole and Control were applied. All the treatments showed the good performance in controlling sooty mold of mango disease compared with control. The treatment of Admire and Cypermethrin with Propiconazole were more effective against sooty mold of mango. Among the mango varieties, BARI aam 1, BARI aam 2 and BARI aam 3, BARI aam 3 showed more susceptibility against the sooty mold.

Efficacy of fungicides in controlling brown/black spot of litchi

An experiment was conducted in established litchi orchard at Fruit Resaerch Station, Binodpur, Rajshahi during 2015-16 cropping season. Efficacy of four fungicides namely Dithane M-45 (Mancozeb), Bavistin (Carbendazim), Tilt (Propiconazole) and Amister Top (Azoxystrobin+ Difenoconazole) were used in controlling black spot of litchi. No significant effects of four fungicides were found in BARI Litchi-1 but a little bit diference was found in Bombai litchi. The range of incidence of brown/black spot was 9.02-13.36% and 1.59-3.53% in BARI Litchi-1 and Bombai litchi, respectively. Although significant difference was found in Bombai litchi but disease incidence was too low.

Efficacy of new fungicide in controlling foot rot of betelvine

Two betel vine farmers ‘boroj’ infected by foot rot caused by Sclerotium rolfsii were selected for tesingn the efficacy of new fungicides at Mohonpur, Rajshahi during July-Sep, 2015. In both trials, after 5 sprays, lowest percent mortality was recorded in Amistar Top @ 0.1% treated plot followed by Amistar Top @ 0.05% treated plot but theywere statistically identical with each other.The highest percent mortality was recorded in control plot followed by Trooper and Bavistin. The highest disease reductions over control in Amistar top @ 0.1% were 96.07% and 94.21% in 1st and 2nd trails, respectively. Similar trial was also conducted in the previous year (2014-15) in the same area but different farmer ‘boroj’ and found same trend of results. Betelvine is a chewing material and that is why finally lower dose (Amistar Top @ 0.05%) of fungicide might be suggested for farmers in controlling foot rot of betelvine.

Efficacy of fungicides and botanical extracts in controlling leaf spot/leaf blight of coconut

The experiment was carried out to find the efficacy of four fungicides,Tilt 250 EC (0.05%), Bavistin (0.15%), Knowing 50 WP (0.2%) and Score (0.05%),two botanical extracts viz. Garlic extract and neem extract, against Pestalotia spp. causing leaf spot or leaf blight of coconut saplings. The botanicalextracts were prepared from the crude plant extracts and their extracted oils. Among them, neem extracts was found effective followed by Bavistin and Tilt fungicides against Pestalotia spp. of coconut.

Biological control of anthracnose disease (*Colletotrichum* sp.) of chilli

This experiment was conducted during winter, 2015-2016 in the field of plant pathology division, BARI under natural condition. The treatment T_2 (foliar spray of Bavistin) showed highest disease control 59.87% and highest yield increase 51.42% followed by T_3 (foliar spray of Micro tech 1) which showed 46.08% disease control and 20.77% yield increase.

Screening of Bangladeshi phytopathogenic fungus, *Sclerotium rolfsii* for mycoviruses with virocontrol potential

A screen of Bangladeshi plant pathogenic fungal isolates *Sclerotium rolfsii* that was among the most destructive soil-borne fungal pathogens of over 500 plant species for viruses with great virocontrol potential was carried out in the Virology laboratory of Okayama University, Japan. Fifty five *S. rolfsii* strains were collected from a variety of crops such as tomato, eggplant, lentil, chickpea, and okra from different location of the country. After imported in Japan, these fungal strains were cultured on potato dextrose agar (PDA) for extraction of DNA and RNA. The extracted nucleic acids were tested for presence of viruses using rolling circle amplification (RCA) (for DNA viruses) and cellulose column chromatography (for RNA viruses). This fungal species was not used in any study aimed at virus hunting. Once detected, *S. rolfsii* viruses were further characterized molecularly. At an initial stage of the study, nucleic acids could be purified due largely to contamination by something very sticky that hampered their fractionation. This problem was solved by changing culture media from PDA to cellophane-PDA. Consequently, of about 50 strains 5 strains were positive for DNA viruses while 3 were positive for RNA viruses. After digestion with restriction enzymes, amplified DNA by RCA were cloned and prepared for sequencing. DsRNA of possible virus origin were reverse-transcribed and used for library construction for sequence analysis. Subsequent necessary analysis will be carried out by the host laboratory.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen *Sclerotium rolfsii* of lentil

The experiment was conducted to observe the suitability of organic compost and vermi-compost for mass culturing of bio-control agent, *Trichoderma harzianum* and its effectiveness against foot and root rot disease of lentil caused by *Sclerotium rolsfii* and *Fusarium oxysporum*. The formulated *T. harzianum* cultured in two different compost viz. organic compost and vermin-compost is designated as Tricho-organic-compost and Tricho-vermi-compost. The present study revealed that soil amendment with Tricho-vermi-compost and Tricho-organic-compost are considered to be the best treatments in reducing seedling mortality and in increasing yield of lentil. Seed treatment with chemical fungicide such as Provax showed better performance against the disease and its effect at per the soil amendments with organic compost and vermin-compost in reducing seedling mortality and increasing plant growth and yield of lentil.

Effect of tricho-compost against seedling blight disease of barley caused by *Sclerotium rolfsii*

The formulated biological control agent *Trichoderma harzianum* was mass cultured in cow dung based compost materials called Tricho-compost and tested against seedling blight disease of barley caused by soil-borne pathogen *Sclerotium rolsfii*. The spore suspension of *T. harzianum* and chemical fungicide Provax were also used for seed treatment. From this study, it was observed that soil amendment with Tricho-compost was found to be the best treatments for reducing seedling mortality, enhancing plant growth as well as getting higher yield of barley. Seed treatment with chemical fungicide Provax and *T. harzianum* spores suspension was found similar effect for decreasing seedling mortality and enhancing plant growth and yield of barley.

Application of biological soil disinfestation (BSD) for controlling wilt of tomato

Biological soil disinfestation (BSD) is a method of controlling soil borne pests and diseases through anaerobic decomposition of plant biomass incorporated in field soil with irrigation water and covering with sheets. A field trial was conducted on the potentiality of biological soil disinfestation (BSD) in suppressing wilt diseases of tomato in the research field of Regional Agricultural Research Station, Rahmatpur, Barisal. Four types of biomass, viz., mustard plants, rice bran, MOC and kitchen wastes were incorporated into soil as BSD-treatments, whereas other two treatments excludes the biomass and /or polythene covering. All BSD-treatments reduced the incidence to 90-99%, especially for the mustard-treatment (TB) the wilt incidence was only 1.93%. All polythene covered soil including BSD-treated soil showed significant increase of tomato yield as compared with uncovered soil. Among the treatments, mustard-treated soil gave the highest yield (58.18 t/ha).

Management of die-back in mango tree

The *in vitro* experiment was conducted at the Regional Agricultural Research Station, Hathazari, Chittagong during the period 2015-2016 to find out fungal forma special of Diplodia theobromae with its pathogenicity test and finally its suppressive bioassay by the novel species *Bacillus oryzicola* YC7010. Strain YC7007 (2.0×10^7 CFU/ml) revealed significantly ($P < 0.01$) lower disease severity by 1.11 ± 0.2, than the control 5.89 ± 0.4 However, there was no significant difference in the disease severity between the concentrations of 2.0×10^7 CFU/ml and Mock treated plant. YC7010 showed the consistent disease suppression of die-back at 5 days after inoculation (DAI) of pathogen and controlled 82% disease reduction compared with control.

An endophytic novel species *Bacillus oryzae* YC7010 how regenerates grafting projection over coming nursery diseases

The in vitro experiment was conducted at the Regional Agricultural Research Station, Hathazari, Chittagong during the period 2015-2016 to get the successful grafting without the infection of nursery diseases. Novel species *Bacillus oryzicola* YC7010 was subjected to regenerate the reunion of scion and rootstocks. Strain YC7010 (2.0×10^7 CFU/ml) revealed significantly ($P < 0.01$) good performance in the different plant growth promoting parameters viz. number of leaves (8.95 ± 0.27), length of scion (15.8 ± 0.39 cm) and fresh weight (1.75 ± 0.05 gm / scion) followed by control number of leaves (5.65 ± 0.17), length of scion (9.2 ± 0.20 cm) and fresh weight (1.14 ± 0.02 gm / scion) YC7010 showed the consistent grafting success (75%) followed by control (55%).

Efficacy of HYT-D (*Chitosan formulation*) in controlling seedling disease caused by soil borne pathogen *Sclerotium rolfsii* of wheat

A pot experiment was conducted in pot house of Plant Pathology Division during winter, 2015-2016. Each treatment showed significant effect in controlling seedling disease caused by S. rolfsii of wheat. When seed was treated with Provax (T_2) showed highest disease reduction (57%) and yield increasing (135.9%) followed by Trichoderma sp. (T_3) 36.1and 86.3%, respectively. HYT D showed lowest (22.2 and 32, respectively) effect in reducing disease and increasing yield over control.

Control of foot rot disease caused by *Sclerotium rolfsii* of bush bean

An experiment was conducted during winter, 2015-2016 to observe the performance of Provax 200 WP and Trichoderma sp. against foot rot disease of bush bean in the field of Plant Pathology Division, BARI, Gazipur. Soil and seed of bush bean was treated with Provax 200 WP and *Trichoderma* sp to evaluate its performance. Every treatment showed significant result against Sclerotium rolfsii causing foot rot disease. The highest disease reduction (76%) and yield increase (94.2%) was observed in T_4 (soil treatment with *Trichoderma* sp.).

Management of white mold disease of lettuce

An experiment was conducted at the pot house of Plant Pathology Division BARI, Gazipur during 2015-16 with seven treatments. The control treatment gave the highest (72.58) percent of diseases severity of white mold diseases whereas the lowest (21.55) percent of diseases severity was observed from the Rovral treatment. In case of no. of leaf, there was no significant difference among the treatments. In contrast, among the treatments there was no significant variation of height of plant over the control except mustard oil cake. Among the treatments use of Rovral for foliar spray of fifteen days of interval gave satisfactory results to reduce the white mold disease of lettuce.

Management option of sclerotinia rot diseasesof marigold

An experiment was conducted at plant pathology division research field BARI, Gazipur during 2015-16 cropping season to find out effective management option of against sclerotinia rot diseases of marigold.with seven treatments.The highest disease incidence was recorded from control treatment (63 %) whereas the disease incidence from the Rovral was the lowest (20%). The highest (65.35%) percentage of disease severity was recorded from T_7 treatment that means control treatment whereas was the lowest (19.65%) was in Rovral treatment.

Development of eco-friendly management package against foot & root rot and wilt diseases of chickpea

The formulated *T. harzianum* bio-fungicide and organic soil amendment poultry refuse either singly or in combination with seed treating fungicide Provax were tested against soil-borne pathogens, *Sclerotium rolfsii* and *Fusarium oxysporum* of chickpea causing foot & root rot and wilt diseases. From this study it was revealed that soil amendment with Tricho-compost or integration of poultry refuse with seed treatment by Provax performed as the best treatments in reducing seedling mortality and increasing plant growth and yield of chickpea which was significantly differed from the other treatments including control. Seed treatment with chemical fungicide Provax showed better performance against the disease and seed treatments with Trichoderma spores suspension and soil amendment with poultry refuse effect was at per. Both of them reduced seedling mortality and increased plant growth and yield of chickpea.

Formulation of eco-friendly management package against foot and root rot disease of lentil

The experiment was conducted to observe the effect Tricho-composts and integration of organic soil amendment poultry refuse with seed treatment with chemical fungicide Provax against foot and root rot disease of lentil caused by soil-borne pathogen Sclerotium rolsfii. It was observed that soil amendment with Tricho-composts and integration of poultry refuse along with seed treatment with chemical fungicide Provax were the best treatments in reducing seedling mortality and receiving higher yield of lentil which was significantly differed from the other treatments including control. Seed treatment with chemical fungicide Provax showed better performance against the disease which was more or less similar effect as soil amendments with poultry refuse alone and seed treatments with Trichoderma spores suspension in reducing seedling mortality and increasing yield of lentil.

Integrated management of betel vine diseases

The experiment was conducted at RARS, Rahmatpur, Barisal during 2015-2016. Management of betel leaf diseases was conducted by Provax-200(0.2%)+ Ridomil Gold(0.2%), Nativo (0.1%)+ Secure (0.1%),Sunfighter (0.05%)+ Bavistin (0.1%), Filia (0.1 %) + Tilt (0.05 %), Amister Top (0.1%) + Score (0.1%),Cupravit (0.1%)+ Neoban (0.2%), Trooper (0.075%) + Conja (0.2%), Zeal (0.075%) + Amcozim (0.2%), Neem leaf extract (1:1) and *Trichoderma harzianum* under natural condition . From this experiment, it was found that Nativo (0.1%)+ Secure (0.1%) and Provax 200 (0.2%)+ Ridomil Gold(0.2%) effectively control the leaf rot (Phytophthora parasitica), leaf spot (Colletotrichum capsici) and vine rot (Sclerotium rolfsii) diseases of betel vine.

Integrated management of stem rot in sesame

The experiment was conducted at RARS, Rahmatpur, Barisal during 2015-2016. Management of stem rot disease of sesame was conducted to evaluate the effectiveness of integrated packages where Bavistin (0.1%) + Dithane M-45 (0.2%), Nativo (0.1%), Ridomil gold (0.2%), Secure (0.1%) Score (0.1%), Aimstar Top (0.1%) and Neoban (0.1%), were sprayed after 30 DAS and 45 DAS in seed treated (Provax 200 WP) plots. Effectiveness of Neem leaf extract (1:1) and Trichoderma harzanium are evaluated individually in controlling stem rot disease of sesame. Two sprays of Aimstar Top (0.1%) or Nativo (0.1%) or Bavistin (0.1%) + Dithane M-45 (0.2%) after 30 DAS and 45 DAS effectively control the stem rot (*Macrophomina phaseolina) disease of sesame.*

Management of phytophthora blight on bottle gourd

The experiment was conducted at RARS, Rahmatpur, Barisal during 2015-2016. Management of Phytophthora blight on bottle gourd was conducted by seed treatment with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2% and spraying Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, Nativo 75 WG (Tebuconazole+Trifloxystobin) @ 0.1%, Neoban 72 WP (Mancozeb + Metalexyl) @ 0.2%, Secure 600 WG (Fenamidone+ Mancozeb) @ 0.1%, Score (Difenoconazole) @ 0.1%, Aimstar Top 325 SC (Azoxystrobin +Difenoconazole) @ 0.1%, Melody duo 66.8 WP (Propineb + Iprovalicarb) @ 0.1%, Filia 525 SE (Tricyclazole + Propiconazole) @ 0.1 %, Timseen Tm (n –alkyl dimethyl benzyl) @0.1%, Mancosil 72 WP @ 0.2% and *Trichoderma harzanium* under natural condition. From this experiment, it was found that seed treatment with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2% and two sprays of Aimstar Top (0.1%) /Nativo (0.1%) /Secure (0.1%) and Timseen (0.1%) effectively control the phytophthora blight disease of bottle gourd.

Integrated management of cercospora leaf spot of Indian spinach in the southern region

The experiment was conducted at RARS, Rahmatpur, Barisal during 2014-2015. Management of cercospora leaf spot of indian spinach was conducted by Hot water treatment (100-104^{o}F/10 min) of seeds, Seed treatment with Provax200 (Carboxin + Thiram) @ 0.2 % and spraying with Score 250 EC (Difenoconazole) (0.1%), Seed treatment with Trichoderma strain, Spraying with PRH (a Japanese plant hormone), Seed treatment with Provax200 (Carboxin + Thiram) @ 0.2 % and removal of diseased leaf, Seed treatment and spraying with Bavistin DF (Carbendazim) @ 0.1%, hot water treatment and spraying with Filia 525 SE (Tricyclazole + Propiconazole) @ 0.1 %, and Spraying with Cuprafix (Cu + Mancozeb) @ 0.2% under natural infection condition. From this experiment, it was found that seed treatment with Provax200 (Carboxin + Thiram) @ 0.2% and two sprays of Score 250 EC (Difenoconazole) @ 0.1% effectively control the cercospora leaf spot on Indian spinach.

Effect of planting time and spray schedule on developmentof stemphylium blight of lentil

The experiment was conducted at Regional Agricultural Research Station, Jessore during Rabi 2015-16. The experiment was laid out in a Split plot design with four main plots and four subplots in each main plot. Four planting time were applied as main plot treatment such as MP1=25th October, MP2=5th November, MP3=15th November and MP4=25th November, 2015. On the other hand, four spray schedule were placed as subplot treatment in each main plot, as SP1=40 DAS, SP2=50 DAS, SP3=60 DAS and SP4=70 DAS. Among the treatments MP2, where planting date was 05 November 2015, and SP3, where the spray schedule started at 60DAS showed better performance for reducing (2.00) stemphylium blight disease severity and increasing yield (1485 kg/ha) of lentil.

Integrated management of wilt complex disease of chili

The experiment was conducted at Regional Agricultural Research Station Ishurdi, Pabna during rabi season 2015-16 to find out an effective management practices against wilt complex disease of chili. Eight treatments viz. T_1= Seedling treatment with Bavistin + Soil drenching with Bavistin @ 0.2%, T_2= Soil application with Stable Bleaching powder @ 20 kg/ha, T_3= Soil application with Calcium Nitrate @ 1% solution, T_4= Soil treatment with poulty litter (5t/ha), $T_5=T_1+T_2+T_3$, $T_6= T_1+T_2+T_4$, $T_7= T_1+T_3+T_4$, T_8= Control were tested for their performance against the disease. All the treatments showed significantly better performance over the control. Treatment T_7 performed the most satisfactory result by controlling wilt complex disease and increased yield than other treatments.

Management of foot and root rot disease of bush bean

The trial was conducted at Regional Agricultural Research Station Ishurdi, Pabna during 2015-16 to find out an effective management practices against foot and root rot disease of bush bean. Six treatments viz. T_1= Seed treatment with Provax @ 2.5 g/kg seed, T_2= Soil treatment with poultry liter @ 5 t/ha, T_3= Spraying of Provax +Bavistin (1:1) at crown region- 2 times, $T_4= T_{1+} T_{2+} T_{3,}$ $T_5= T_{1+} T_{3,}$ T_6= soil drenching with sapnil (0.5%) and T_7 =Control were tested for their performance against the disease. All the treatments showed significantly better performance over the control. Treatment T_4 gave the most satisfactory result by controlling foot and root rot disease and increased yield than other treatments.

Evaluation of potato late blight management utilizing host plant resistance and frequency of fungicide application

An experiment was undertaken at Regional Agricultural Research Station, Burirhat, Rangpur during the rabi season of 2015 – 2016 to observe the effect of spray frequencies of fungicide (mancozeb) in controlling potato late blight disease and to establish an appropriate spray interval for resistant and suscceptible potato variety. There were two resistant varieties namely BARI Alu-46 and BARI Alu-53 and a susceptible variety Diamant. Four spray frequency of fungicide (Dithane M 45@ 0.2%) were 1. Seven spray with 7 days interval 2 .Five spray with 10 days interval 3. Four spray with 15 days interval 4. Three sprays with 20 days interval and one unsprayed plot were also maintained for each variety. From the results it is revealed that disease severity was increased as the frequency of spraying decreased. In case of yield higher yield was obtained from higher spray frequency but in case of BARI Alu 46 statistically similar yield was obtained from all the frequencies.

Effect of planting time on the late blight disease of potatoin the resistant variety/lines

The experiment was conducted during the rabi season of 2015 – 2016 at Regional Agricultural Research Station, Burirhat, Rangpur to observe the effect of planting time on late blight disease and yield. There were three planting time and three varieties in this experiment. The planting time were 15 November, 30 November and 15 December. Out of three test varieties there were two resistant varieties namely BARI Alu-46 and BARI Alu-53 and a susceptible variety Diamant. The results indicated that late blight severity was increased with the concomitant decrease of yield due to delayed planting. The resistant variety BARI Alu 46 gave the highest yield (59.36 t/ha) with lowest disease at 30 November planting.

Management options of sclerotinia rot of marigold

An experiment was conducted at RARS, Burirhat, Rangpur during 2015-16 to evaluate the fungicides and bio-fungicide for controlling sclerotinia rot of marigold. Treatments were soil application of Tricho-compost (2.5 t/ha), application of poultry refuse in the soil @ 6 t/ha, soil drenching with Mustard Oil Cake (600kg/ha), Soil drenching with Contaf 5 EC (0.1%), spray with Rovral 50 WP (0.2%), spray with Tilt 250 EC (0.1%)) and control. Only soil application of bio-fungicides or chemical had very little in controlling sclerotinia rot of marigold. The highest Sclerotinia rot severity (68.02%) was found in untreated control plots and there were no significant differences on the effect of Tricho-compost and Mustard Oil Cake with control. Spray with Rovral was most effective against the disease where severity was lowest (29.99%) followed by Tilt (38.56%). Soil drenching with Contaf and Soil application of poultry refuse had some effect against the disease where severity was about 55%.

Study on the relationship of weather factors in developing alternaria blight of mustard

An experiment was conducted at RARS, Jamalpur to find out the effect of weather factors on the severity of alternaria blight of mustard. The highest disease score 4.9 was recorded in December 11 sowing followed by 4.6 in December 01 sowing. The lowest disease score 2.8 was recorded in November 01 sowing at Jamalpur. The highest seed yield 1.67 ton/ha was observed in November 01 and the lowest seed yield 0.88 ton/ha was found in December 11 sowing at Jamalpur.

Survey of the disease infected guava field of different upazila of Chapainababgonj

This experiment was conducted during March to May, 2016. Symptoms were as like as wilt disease such as browning and wilting of leaves, desiccated twigs, discolored stem, dead branches often from one side of the plants and discolored vascular tissue. *Fusarium* sp. and *Pestalotia* sp. were isolated from infected plant parts. In addition, abundance of plant parasitic nematode and Aphelenchus sp.were 90.34 and 55.66% in rhizosphere, respectively.

Status of panama and sigatoka diseases of banana in Bangladesh

The study was conducted to assess the prevalence and severity of sigatoka and panama diseases of banana during April to September 2015. Fifty locations were visited in eighteen upozilas of Narsingdhi, Tangail, Bogra, Gaibandha, Rangpur and Jessore districts with the objectives to confirm the documention of the status of panama and sigatoka diseases and for their isolation, identification, purification and preservation. Prevalence of panama and sigatoka diseases were found in the every area surveyed. Incidence and severity of Panama and sigatoka diseases were found with different percentages at different areas of Bangladesh. Incidence of panama disease ranged from (10.33-

32.67%). The highest rate (32.67-56.67%) found at Modhupur, Tangail and the lowest (10.33 - 28.83%) at Taragonj, Rangpur. The highest severity (28.30 - 63.67%) of panama was found at Shibgonj, Bogra and lowest (11.33-26.00%) at Jhikorgacha, Jessore. The highest incidence and severity of sigatoka disease were found 54.33 and 85.67% respectively, at Modhupur, Tangail. The lowest incidence of sigatoka disease was 21.90% at Polashbari, Gaibandha and the lowest severity of sigatoka was 42.67% at Jhikorgacha, Jessore.

Survey, isolation and identification of major diseases of gerbera flower

A survey was carried out in different Gerbera gardens in Godhkhali of Zhikorgasa upazilla of Jessore district during October 2015 to January 2016 cropping season. Plant samples (viz. leaf, stem and flower) were collected and brought in the Plant Pathology Laboratory for identification of the disease and pathogen following standard method. The pathogens were isolated from the samples following the "Tissue Plating method". The isolated fungi were identified based on morphological characteristics observed under a compound microscope comparing standard keys. Four species of fungi namely *Erysiphe cichoracearum*, *Botrytis cinerea, Stemphyllum* sp. and *Colletotrichum* sp. were isolated from the infected plant parts of Gerbera which were responsible for the diseases of Powdery Mildew, Botrytis Blight, Stemphyllum Blight and Anthracnose leaf spot of Gerbera, respectively.

Survey of major diseases of vegetables, fruits and pulses at Pabna region

A survey of important crop diseases at Ishurdi, Pabna region was conducted during rabi season of 2015-16. Disease assessments were done in 10 locations of Ishurdi region. From the survey it was found that in case of vegetables, Anthracnose of country bean, cercospora leaf spot of brinjal, little leaf of brinjal, leaf curl virus of chilli were major diseases. Foot and root rot and stemphylium blight of lentil, rust of lentil were concidered as major disease of pulses crops. White mold and alternaria leaf blight of mustard are major diseases of mustard. Sigatoka diseases of banana, leaf spot of litchi and anthracnose of guava were found as major fruit crop diseases in Ishurdi, Pabna region.

Survey of white mold disease of different crops at Pabna region

A survey of white mold disease of different crops at Pabna region was conducted during rabi season 2015-16. Disease assessment was done in 9 locations of Pabna region. From the survey it was found that in case of white mold of mustard, disease incidence was high in RARS Ishurdi and Cholonbil, Natore. Bushbean, country bean and marigold were suffered with medium incidence of white mold disease. Lower white mold disease incidence was observed in sun flower, eggplant and lentil from different surveyed areas.

Survey of sclerotinia rot disease of different crops in Rangpur district

A survey was carried out in different locations of Rangpur district in February 2016 to know the status of Sclerotinia rot disease in different crops in this region. Sclerotinia rot incidence and severity were recorded in 9 crops from 68 farmer's fields in 16 locations of 4 upazillas of Rangpur. The incidence and severity varied from 2 to 70% and 2 to 60% in different crops, respectively. The maximum incidence 10 - 70% was observed in tomato followed by napashak 20 - 50% and the minimum 5 - 20% in both red amaranth and carrot. Severity was highest 2 - 60% in mustard followed by napashak 5 - 55% and tomato 10 - 50%. Lowest 2 - 5% severity was found in country bean.

Survey and identification of causal pathogen of brown/ black spot of litchi at Rajshahi region

A survey on incidence of brown/black spot of litchi was conducted at Rajshshi region during 2015-16. Incidence of brown/black spot ranged from 6.53-16.21% (average 9.77%) and 1.53-2.71% (average 1.98%) in BARI Litchi-1 and Bombai litchi, respectively. Colletotrichum sp., Alternaria sp. and Fusarium sp. were found as the causal agents from most of the diseased samples. While pathogens were not found from rest of the collected samples, the reason might be due to sunburn or other unknown occurences. So, causal agent of brown/black spot of litchi might be complex.

Nematode Diseases Management

Screening of neem products against root-knot nematode, *Meloidogyne incognita* of tomato

The experiments were conducted in the field of Plant Pathology Division, BARI during 2015-16 cropping season to evaluate the neem based products such as neem leaf powder, neem leaf extract, neem seed extract, neem oil and neem oil cake for the management of root knot nematode of tomato caused by *Meloidogyne incognita*. Root knot nematode infested field soils were treated with those neem based producst as well as chemical nematicide Furadan 5G. It was revealed that all the treatments gave appreciable reduction of gall development on roots and increased plant growth parameters such as shoot and root growth as well as yield of tomato. Among the treatments, neem seed extract and neem oil cake appeared to be the best amended materials for reduction of root knot nematode disease incidence and improvement of plant growth as well as getting higher yield of tomato. Application of neem leaf extract and neem leaf powder were also better as chemical nematicide Furadan 5G in reducing root knot nematode disease incidence and increasing plant growth as well as yield of tomato.

Management of root- knot disease of egg plant through the application of nematicides and different organic amendments

A field experiment was conducted at Regional Agricultural Research Station Ishurdi, Pabna during rabi season, 2015-16 to find out effective management practices for controlling root-knot nematode (Meloidogyne incognita) of egg plant. Six treatments viz. T_1= Furadan 5G @ 25 kg/ha, T_2= Poulty litter @ 5t/ha, T_3= Mustard Oil cake @ 800kg/ha, T_4= Furadan + Poulty litter, T_5= Furadan + Mustard Oil cake and T_6= Control were used in this experiment. All the treatments gave satisfactory reduction of gall development on roots and increased plant growth as well as yield of egg plant. Among the treatments Furadan+ Poulty litter treated plots showed significanl reduction of gall and increased yield over control.

Bacterial Diseases Management

Up-scaling and validation technology for rhizome rot disease management of ginger

The study was conducted to assess the disease severity and yield of ginger during November, 2014 to March, 2015. Twelve upazillas of Nilphamari, Rangpur, Tangail, Bogra, Lalmonirhat and Mymensingh districts were surveyed with the objectives to select ginger farmers and to train up them about the ginger diseases; to make understand the farmers about the infected and healthy seeds and to separate them; and finally to provide management package of diseases in the field during next year cultivation. The main emphasis of the farmers training was to teach them practically for selecting healthy seeds before sowing. Then it was discussed step wise to set up the application of different inputs such as seed treatment with Bordeaux mixture; spraying Chlorox or Ridomil Gold in standing crop. The disease incidence and yield significantly differed among the locations. The highest disease incidence was recorded from Sadar Nilphamari and the lowest in Shajahanpur in up-scaling program and it ranged from 5.22-29.5% but the yield was also lowest in Shahajahanpur. The highest yield was recorded in Shibganj, Bogra among the project areas. The disease incidence in the farmers pot (Control) was ranged 11.26-46.50% and the yield in control plot was poor due to heavily infected seed materials. It is clear that disease incidence was lower in up scaling program and it ranged from 5.22-29.5% whereas it was higher in control plot, ranged 11.26-46.50%. As a result, yield also drastically reduced in control plot. The disease incidence and yield also differed significantly among the locations of newly adopted areas. The highest disease incidence was recorded from Muktagacha and the lowest in Sadar Lalmonirhat. The highest yield was recorded in Aditmari among the adoption areas.

Collection, isolation and characterization of bacterial wilt pathogen from different host

Sixteen samples were collected from surveyed area, among them 7 from brinjal, 5 from tomato and 4 from ginger. The pathogen was isolated on specific medium and pure bacterial colonies were preserved for future study.

16 PLANT PHYSIOLOGY

Developmental stages, growth indices and yield of hybrid maize cultivars as affected by growing seasons

An experiment was conducted to evaluate the developmental stages, growth and yield performance of hybrid maize varieties in *rabi* 2014-15 and *kharif-1* season of 2015. Four maize varieties, namely, BARI Hybrid Maize-7, BARI Hybrid Maize-9, Pioneer and NK-40 were used as test varieties. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 4.2 m x 3 m. In *rabi* season, seeds were sown on 18 November, 2014 and in *karif-I* season seeds were sown on 10 March, 2015 with 60 cm x 20 cm spacing. Fertilizers were applied at the rate of 250-55-100-30 kg/ha N, P, K and S as urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum. One third of N and whole amount of TSP, MOP and gypsum were applied as basal. Remaining 2/3 N was top-dressed at 40 and 70 days after sowing (DAS) in *rabi* season while at 35 and 50 DAS in *kharif-I* season. Irrigation was given as and when required to maintain adequate soil moisture. Canopy light interception was measured with PAR (Photosynthetically Active Radition) Ceptometer (LP-80, AccuPAR, Decagon, USA) at different growth stages and plants were sampled for leaf area and dry matter measurement. Leaf area was measured by an automatic area meter (LI-3100 C, LI-COR, USA). Maize was harvested at physiological maturity (rabi season 145 to 147 DAS and kharif-I season 96 to 99 DAS). Seasonal effect showed remarkable influence on pehnological development, growth duration, dry matter production and grain yield of hybrid maize but varietal influences were not so prominent. Rabi maize received lower temperatures (mean temperature 13.75 to 29.4 ^{o} C) which prolonged its phenological development and growth duration (145-146 days for physiological maturity), produced higher leaf area index (3.5 to 4), intercepted more light (PAR) energy (90-93%), produced higher total dry matter (2600 to 2850 g/m^2), which contributed to higher grain yield (10.67 t/ha). On the other hand, kharif maize received higher temperatures (daily mean temperature 20.6 to 32.6^{o} C), which enhanced its phenological development but shortened its growth duration (96 to 99 days for physiological maturity), produced lower leaf area index (2.8 to 3.3), intercepted less light (PAR) energy (80-85%), produced lower total dry matter (2100 to 2400 g/m^2), which contributed to lower grain yield (8.54 t/ha).

Evaluation of growth and yield of chickpea genotypes for rainfed condition

An experiment was carried out at the field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-2016 to find out suitable chickpea genotypes for rainfed condition. Five genotypes viz., BD-6309, BD-6745, BD-6772, BD- 6775 and BARI Chola-9 were tested. The crop was fertilized with 33-24-45-21-2-1 kg/ha NPKSZnB (FRG, 2012) in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid. All fertilizers were applied as basal during final land preparation. Unit plot size was 3m x 1m. Seeds of each genotype were sown on 29 November, 2015 with 40 cm x 10 cm spacing. Pre-sowing irrigation was applied for ensuring seed germination and then the crop was grown under rainfed conditions. Intercultural operations and plant protection measures were done when necessary. Soil sample was collected at 15 days interval at 15 and 30 cm depth of soil for determination of moisture. BARI Chola-9 and BD-6775 were found better on the basis of leaf area, chlorophyll content, dry matter accumulation, seed yield (17.36g/plant to 18.69g/plant) and yield attributes under rainfed conditions.

Evaluation of light interception, radiation use efficiency, growth and yield of BARI Alu-13 under variable plant density

An experiment was carried out at the field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-16 to evaluate light interception, radiation use efficiency, growth and yield of BARI Alu-13 under variable plant density**.** The treatments included four plant spacing viz. 60 cm × 25 cm, 60 cm × 15 cm, 50 cm × 25 cm and 50 cm × 15 cm. The unit plot size was 4m×3m. Whole tubers were planted on 16 November, 2015 as per treatment. Well decomposed cowdung was applied @ 5 t/ha before land preparation. Fertilizers were applied @ 150-45-125-20 kg/ha N, P, K, S in the form of urea, triple super phosphate (TSP), muriate of potash (MoP) and gypsum, respectively. Full amount of TSP, MoP, gypsum and 50% of urea were applied as basal during planting and the remaining amount of area was side dressed at 31 days after planting. Weeding, irrigation, earthing-up and other intercultural operations were done as and when necessary. Significant variations were found among the treatments for plant height, total dry matter (TDM) and radiation use efficiency (RUE) in different developmental stages. The highest RUE was recorded in 50 cm × 25 cm spacing. Moreover, number of stems per plant, number of tubers per plant, tuber fresh weight per plant and tuber yield (32.8 t/ha) were obtained highest from 50 cm × 25 cm.

Performance of selected wheat genotypes under salinity in pot culture

In order to evaluate the salt tolerance characteristic of wheat germplasms, a pot experiment was conducted in vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-2016. Nine selected genotypes/varieties of wheat viz., BAW-1135, BAW-1157, BAW-1214, BAW-1220 BAW-1222,BAW-1223, BAW-1195 ,BARI Gom-25 and BARI Gom-29 were tested for their salt tolerance at different degrees of salinity (0, 8 and 12 dS/m of NaCl). The study was evaluated under completely randomized design with four replications. Earthen pots (12 L, 30 cm height) were filled with soil and cow dung in 4:1 volume ratio. Fertilizer 120-30-90-15-6-2-1 kg/ha of NPKSMgZnB (FRG, 2012) in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid were incorporated in the soil. Ten seeds of each genotype were sown in each pot on 29 November, 2015. Thinning of seedling was done by keeping five plants for each pot at 10 days after sowing. The pots were irrigated with tap water to grow crop without moisture stress. At early vegetative stage (2 weeks after sowing), salt solutions were applied in pot as per treatment. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 8 and 12 dS/m solution. Tap water was used as control and that was 0.25 dS/m. The salt solution was applied with an increment of 2.5 dS/m in every alternate day till respective salinity level of 8 and 12 dS/m were attained. Genotypes/varieties greatly affected by salinity level in respect to SPAD value, leaf area, leaf dry weight, root volume, root and shoot dry weight, days to heading and flowering, plant height and number of tiller as compared to control. Higher salinity levels reduced growth and yield parameters. Genotypes BAW-1135 and BARI Gom-29 showed maximum relative values in all the above mentioned parameters. In respect of growth and yield BAW-1135, BAW-1195 and BARI Gom-29 showed more tolerance up to 12 dS/m salinity level. The experiment will be repeated in the next season for final confirmation and recommendation.

Screening of wheat genotypes for drought tolerance at vegetative stage

Screening of wheat genotypes for drought tolerance was done at the vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Gazipur, during *rabi* 2015-16. Twenty three wheat genotypes collected from Wheat Research Centre of Bangladesh Agricultural Research Institute, were evaluated against drought at vegetative stage. Ten seeds of each genotype were sown in each pot on 30 November, 2015. Thinning of seedling was done by keeping five plants for each pot at 10 day after emergence. Drought treatment was imposed during vegetative stage. The experiment included two treatments viz. control (no drought), in which pots remained humid (at a 50-60% water holding capacity throughout growing period); and drought in which 2 L water was added to each pot and the plants were then subjected to drought stress from CRI to before anthesis by withholding irrigation. The experiment was done in Randomized complete block design with nine replications. The results showed that SPAD value, plant height, leaf area and biomass of shoot were significantly reduced in plants exposed to drought stress compared with control plants. There were significant differences among the 23 wheat genotypes in terms of the reduction in these growth parameters. Genotypes G5 and G6 showed the least reduction, indicating their high tolerance to drought stress, while genotypes G8 and G9 showed the greatest reduction, and drought stress symptoms appeared rapidly and severely in these genotypes. Significant genotypic differences in leaf total soluble sugar (TSS) content in response to drought stress were also observed. The drought tolerant genotype G5 showed a higher TSS and the two drought-sensitive genotypes G8 and G9 showed a lower TSS than the control plants. On the basis of relative yield (RY), stress susceptibility index (SSI) and stress tolerance index (STI), the genotypes G5, G6, G17 and BAW1208 were selected as drought tolerant at vegetative stage.

Physiological changes in wheat genotypes under high temperature stress at reproductive stage

Four wheat genotypes, namely, BARI Gom 28, BARI Gom 29, BARI Gom 30 and BAW 1208 were sown in vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Gazipur on 30 November, 2015 to know the mechanisms of heat resistance during reproductive stages. Two temperature regimes, namely, normal (24°C in open field) and elevated (10±1°C higher compared to open field mean air temperature in polythene chamber) temperature, were created immediately after anthesis to investigate the response of wheat genotypes to heat stress. Elevated temperature cuts back the duration of grain filling by 7 days in BARI Gom-28, BARI Gom-29 and BAW-1208. Starch synthesis was also affected in respective genotypes under elevated temperature condition. Results indicate that failure of conversion of sugar to starch rather than limited supply of sugar under high temperature condition were responsible for shortening of grain filling duration in all wheat genotypes. However, in response to elevated temperature, grain starch and grain weight was less affected in BARI Gom-30 and BAW-1208 compared to BARI Gom-28 and BARI Gom-29 indicating their better tolerance to elevated temperature. The maximum reduction of main stem grain weight was recorded in BARI Gom-29 (65%) and minimum in BARI Gom-30 (49%).

Growth, yield and dry matter partitioning of field pea as influenced by shoot clipping

The experiment was conducted at the research field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-16. The experiment was laid out in split plot design with 3 replications. Two field pea varieties (BARI Motor-1 and Natore local) were considered as main plot treatments and four clipping as sub-plot treatments. Four clipping treatments were control (no shoot removal), shoot clipping at 30 days after sowing (DAS), 40 DAS and 50 DAS. The unit plot size was 4 m x 3 m. Pre-sowing irrigation was given to bring the soil at field capacity (zoe condition) at sowing. Seeds of BARI Motor-1 and Natore local were sown on 10 November, 2015. A light irrigation was given in all the plots to ensure proper emergence. Fertilizers were applied at the rate of 20-17-30-3-1.5 kg/ha N-P-K-Zn-B as urea, triple super phosphate, muriate of potash and boric acid. Full amount of all fertilizers were applied as basal. The clippings were done at approximately 5-6 cm above of the main branch. The source-sink relationship among genotypes was different. The BARI Motor-1 had better source strength because of maximum number of leaves, higher dry matter of leaves and higher leaf area. Further BARI Motor-1 had better sink i. e. higher number of pods/plant (14.4) to accumulate more photosynthates as compared to Natore local (6.6). Shoot clipping at 40 DAS may be recommended to get better yield along with vegetable. Finally, it may be assumed that the high yielding BARI Motor-1(680kg/ha) having a better photosynthetic rate and better mobilization of photosynthates during grain filling contributes to their higher yield.

Variability in growth and development of potato varieties

The experiment was carried out at the research field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-16 to evaluate growing degree days for different developmental stages and also to determine the growth and yield of potato varieties. The treatments included four potato varieties viz, BARI Alu-7, BARI Alu-8, BARI Alu-13 and BARI Alu-25. Potato varieties showed variable growing degree days (GDD) at particular developmental stage. Among the varieties, BARI Alu-25 took maximum GDD and growth duration compared to other varieties. BARI Alu-13 needed minimum GDD as well as shorter growth duration. Leaf area index (LAI) gradually increased and there after it showed declining trend. Variety BARI Alu-7 showed the highest LAI followed by BARI Alu-8 and BARI Alu-25 and the lowest LAI was found in BARI Alu-13. In all the varieties, changing pattern of specific leaf weight (SLW) was similar. Among the varieties, BARI Alu-7 showed the higher total dry matter (TDM) throughout the growing period followed by BARI Alu-8 and the lowest TDM observed in BARI Alu-13. Irrespective of varieties, crop growth rate (CGR) gradually increased and thereafter showed declining trend. It also observed that CGR is closely related with the absorbed photosynthetically active radiation (PAR). Radiation use efficiency (RUE) was found higher at tuber bulking stage compared to tuberization stage and higher RUE was observed in BARI Alu-7 and BARI Alu-8 followed by BARI Alu-25 and the lowest RUE was in BARI Alu-13. Tuber yield was differed among the varieties. The highest tuber yield was obtained from BARI Alu-7 (27.5 t/ha) and BARI Alu-13 produced the lowest tuber yield (22.3 t/ha).

Study on growth and development of sweet corn at different water regimes

To study the effect of irrigation at different growth stages on growth and development of sweet corn, an investigation was conducted at the research field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2015-16. The treatment included: T_1 = Well watered (Irrigation at 4, 6, 8 leaf stage, silking and tasseling stage) (control), T_2 = Irrigation at 4 leaf stage, T_3 = Irrigation at 4 leaf stage + tasseling stage, T_4 = Irrigation at tasseling stage, T_5 = No irrigation throughout crop period. Seeds of sweet corn (cv. BARI Sweet corn-1) were sown on 12 November, 2015. A light irrigation was given in all the plots to ensure proper emergence. Fertilizers were applied 150-60-90-200 kg/ha of N, P, K and S as urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum. One third of N, whole amount of TSP, MOP and gypsum was applied as basal. Remaining 2/3 N was top-dressed at 30 days after sowing (DAS) and at 55 DAS. Irrigation was given as per treatment. Soil moisture content of the experimental plots was monitored (60 cm depth) throughout the growing season using an auger every 10 days interval from 25 DAS to 90 DAS. SPAD value, leaf area index (LAI), total soluble solid (TSS) and ultimately green cob yield were reduced in T_5 treatment. Among the treatments, T_1 and T_3 showed higher LAI, total soluble sugar (TSS), starch and protein content. Compared with control, all stress treatments significantly reduced cob length, cob diameter, number of grains per cob, green cob weight, green cob yield and green fodder yield; however T_3 was less affected than that of others treatment. The results revealed that irrigation at 4 leaf stage and tasseling stage (T_3) would be suitable for sweet corn cultivation with higher TSS, starch and protein content. Maintenance of higher plant water status helps to improve the quality of sweet corn. Also, it can be confirmed that the vegetative stage followed by tasseling and silking are critical for moisture stress. Moreover, Sweet corn cob should be harvested at 22 days after silking for maximum sweetness.

Adaptability study on selected salt tolerant mustard variety/genotype at saline prone area

An experiment was conducted at the Agricultural Research Station, BARI, Benarpota, Satkhira during the *rabi* season of 2015-16 to find out the suitable mustard variety /genotype for growing in the saline prone areas. There were three varieties/genotypes, namely, BARI Sarisha-14, BARI Sarisha-16 and BD-9093. The yield and yield contributing characters of mustard varieties/lines were significantly influenced by the soil salinity. The highest seed yield (2.54 t/ha) was recorded in BARI Sarisha-16 with the highest BCR (2.89), and the lowest seed yield (1.56 t/ha) was recorded in BARI Sarisha-14. The lowest level of soil salinity (3.22 dS/m) was recorded at the sowing time and the highest level (10.55 dS/m) at the harvesting stage. BARI Sarisha-16 might be cultivated in saline areas sacrificing Boro rice for getting higher yield and economic return.

17 SEED TECHNOLOGY

Judicial use of nitrogen on wheat seed production by digital image analysis system

Wheat yield influenced by nitrogen (N) fertilization. This study investigated the accumulation and partitioning of dry matter (DM) in a wheat variety with different nitrogen doses and to develop a nondestructive method for monitoring wheat growth and N status using a digital camera. Four wheat varieties (BARI Gom-26, BARI Gom-28, BARI Gom-29 and BARI Gom-30) with four levels of nitrogen (0.0, 50, 100 and 150 kg/ha). Leaf SPAD values and dry matter were measured at different growth stages. Digital photos of the wheat canopies were taken at different growth stages. The green and red values were extracted from the digital images and then used to calculate canopy cover by using fertilizer image analysis software. The values of canopy cover were closely correlated with the normalized difference vegetation index and the ratio vegetation index. Models were calibrated to describe the relationship between canopy cover and three growth properties of wheat (i.e., NDVI, LA, and aboveground biomass). There were close exponential relationships between canopy cover and three growth properties. And the relationships for estimating wheat above ground total dry matter were most precise. The coefficient of determination ($R2$) value was 0.978, and the root mean square error (RMSE) value was 1.479 g m^{-2}. The result indicated that the best relationship between canopy cover and aboveground total dry matter had $R2$ value of 0.926 and an RMSE value of 1.631 g m^{-2}. As a near-ground remote assessment tool, digital cameras have good potential for monitoring wheat growth. It could be concluded that application of nitrogen fertilizer has positive effects on Physiological parameter of wheat cultivar. Potential use of digital camera as a tool combined with software to make nitrogen fertilizer recommendation for large fields of wheat.

Salt (NaCl) effect on seed germination and seedling growth of corn

Soil salinity is one of the most principal challenges for salt sensitive crop production. At seedling stage, it is required to find out the less salt tolerant hybrids for cultivation in saline area. An investigation was conducted on maize salinity at germination stage in green house of Plant Breeding division of Bangladesh Agriculture Research Institute (BARI), Joydebpur, Gazipur. Germination test were carried out with four replications and three level of salt concentration (0 dS.m^{-1}, 6 dS.m^{-1} and 12 dS.m^{-1}) in plastic tray under quartz granules. Each tray contained 100 seeds with four replications and each replication bear 25 seeds. Analysis of variance (ANOVA) indicated that all traits were significant at $P<0.01$ for genotypes, treatment and their interactions. A significant difference was investigated among 33 hybrids maize in salt stress. The present study directed that the application of high level of salt, adversely affected the germination indices and seedling growth of all maize hybrids. Germination percentage (GP), germination speed (GS), germination index (GI), root length(RL), shoot length(SL), total dry matter (TDM), and salt tolerance index (STI), seed vigor index (SVI) were all decreased as the level of NaCl was increased. Mean germination time (MGT) and per cent reduction in dry weight over control (%ROC) was increased as the NaCl concentration increased. In case of seminal root (SR), most of the genotypes produced higher number seminal root at high salt stress. Among the hybrids, 962, 900M gold, super gold, PAC999 and 9120 were demonstrated less salt impact, but Prince, 981, 987K and P339 were exhibited high salt effect. Therefore, these hybrids would be used for salt tolerant breeding program as decent genetic materials.

Seed yield and quality of pea as influenced by phosphorus level and mycorrhizal association

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Jaydebpur, Gazipur, during *rabi* season of 2015-16 to find out the optimum phosphorus level and mycorrhizal association for quality seed production of pea. The experiment was laid out in split plot design with two mycorrhiza treatments (viz., without mycorrhiza and with mycorrhiza) and four levels of phosphorus (viz., 0, 20, 40 and 60 kg P/ha). Phosphorus was used in the form of TSP. Garden pea variety was BARI Motorshuti-3. Dry matter production at 60 days after sowing (DAS) and 75 DAS, plant height, number of pod plant^{-1}, pod length, seed per pod and finally seed yield was significant under different level of phosphorus fertilizer. After harvesting the seed germination, root length, shoot length and seed vigour index were significant under different level of phosphorus fertilizer and mycorrhiza. Plant height, pod number per plant, pod length, seed per pod and seed yield was found maximum when 40 kg P was used. This phosphorus dose also showed maximum seed germination rate, root length, shoot length and finally seed vigour index. From the study it was observed that 40 kg phosphorus with or without mycorrhizal association gave the highest seed yield and seed quality parameters of Garden pea.

Seed development pattern of garden pea

The experiment was conducted at the research field of Seed Technology Division, BARI, Joydebpur, Gazipur, during the period from November 2015 to March 2016 to find out the grain growth pattern and harvest maturity period of garden pea (var. BARI Motorshuti-3). Five days interval data was recorded starting from anthesis up to harvest. Pod length increased rapidly up to 15 days after anthesis (DAA) and then increasing slowly. Seed per pod was highest at initial stage but before seed setting it was decreasing. After 15 DAA, the seed number per pod was statistically similar up to harvest. Seed moisture content and dry matter of seed were significant at different dates of harvest. Single seed dry weight was increasing after anthesis and maximum was found from the seed of 40 DAA and it was statistically similar with 45 DAA. Seed germination was recorded maximum at 45 DAA which was identical with 35 DAA and 40 DAA. Statistically the highest root length (12.53 cm) and highest shoot length (12.23 cm) was recorded from 45 DAA. Individual seedling dry weight was found maximum (67.38 mg) from the seed of 40 DAA and it was statistically identical with 45 DAA. Seed vigor index was maximum (5898.9) from the seed of 40 DAA although it was statistically similar with 45 DAA. From the study it can be concluded that garden pea seeds were physiologically matured at 40-45 days after anthesis.

Integrated weed management in summer mungbean for quality seed production

The field experiment was carried out at the research field of Seed Technology Division, Bangladesh Agricultural Research Institute (BARI) during *kharif-1* season of 2016 to know the effect of different weed management practices and their effect on yield attributes and seed quality of mungbean. There were 8 weed management practices such as no weeding (control) (T_1), glyphosate spraying at one week before sowing (T_2), wheep super spraying at 2 to 4 leaf stage of weed (T_3), spading between the rows at 20 days after sowing (DAS) (T_4), hand hoeing at 20 DAS (T_5), T_6=T_2+T_5, T_7= T_3+T_5, T_8= Weed free. Mungbean variety was BARI Mung-6. Weed biomass were significantly influenced by different management practices. At harvest the lowest weed biomass (5.5 g m^{-2}) were obtained from weed free treatment and the highest (1149.3 g m^{-2}) weed biomass was found from T_1 treatment. Seed yield was recorded maximum (1347 kg /ha^{-1}) from T_8 treatment and the lowest seed yield (211 kg ha^{-1}) was found from control plot (T_1). After harvest, the seed germination rate was found maximum (83%) from T_8 treatment and it was statistically identical with T_6 and T_7 treatment. The lowest seed germination rate (40%) was recorded from T_4 treatment and it was statistically similar with control (T_1) treatment. Root length and shoot length of the tested seed were found maximum from T_8 treatment and minimum were recorded from control (T_1) treatment. The highest seed vigor index (2468) was recorded from T_8 treatment and it was statistically similar with T_6 and T_7 treatments. From the study it was observed that weed free treatment gave the superiority of all other treatments with respect to seed yield and yield attributes along with seed quality parameters. But in case of chemical control of weed, glyphosate spray at one week before land preparation and one hand weeding at 20 DAS gave the better performance for quality seed production of mungbean.

Effect of plant spacing and fruit load on quality seed production of capsicum

A field experiment was conducted at the research field of Seed Technology Division, BARI, Gazipur, during 2015-2016 to know the optimum plant spacing and number of fruit retaining for quality seed production of capsicum. Three spacings viz. 50 x 30 cm, 50 x 40 cm and 50 x 50 cm and three fruit load viz. four fruits, six fruits, eight fruits per plant were included in this experiment. At flowering stage only the specified number of buds were allowed to grow for anthesis and fruit development and remaining were pinched off at the initial stage. The variety of capsicum was BARI Mistimorich-1. Significant variations due to spacing, fruit load per plant, and interaction between spacing and fruit load per plant were found among the variables such as individual fruit weight, number of seed/fruit, seed weight/fruit, seed yield/plant, seed yield/ha (kg), 1000 seed weight (g), seed germination (%) and seedling vigour index. Best quality seeds as well as higher seed yield were obtained from medium spacing (50 cm×40 cm) with retention of six (6) fruits/plant.

Effect of post- harvest fruit storage on seed quality of pumpkin

A field experiment was laid out in the field of Seed Technology Division, BARI, Joydebpur during December 2014-April 2015 to evaluate appropriate post-harvest fruit storage period for quality seed production. The pumpkin variety were BARI Mistikumra-2 and Khagrachari local cultivar. Pumpkin fruits were stored up to five months in room condition for observing the seed quality. Weight loss occurred in fruit in both varieties upto 5 months during storage period due to water evaporation, which resulted in dehydration of fruits leaving pithy pulp and seed mass intact. The fruit weight loss was 26 percent and 35 percent in BARI Mistikumra 2 and Local cultivar. Germination of seeds increased from 59% (0 months) to 99% after four months of storage in BARI Mistikumra-2. On the other hand, in Local cultivar, germination of seeds significantly increased from 71 per cent (0 months) to 100 per cent after one month of storage and it was stable till three months of storage. The continued development of mature embryos and development of desiccation tolerance during post-harvest ripening might be the probable reason for better germination during these periods of storage. The very low germination (59%) was observed in fresh harvested fruit in BARI Mistikumra-2 at initial month of storage might be due to the dormancy associated with fresh seeds. There was a slight decrease in germination indicating the onset of seed deterioration inside the fruit during storage of 3 to 4 months. The highest vigour index (9932) was recorded at fifth months after storage in BARI Mistikumra-2 and in Local (7274) at 3rd month after storage. After reaching the peak vigour index then declining trend was noticed.

Effect of seed soaking in water on the germination and plant establishment of French bean in the field

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2015-16 to find out the effect of seed soaking in water on the germination and plant establishment of French bean in the field**.** French bean variety was BARI Jharseem-1. The experiment was laid out in Randomized Complete Block Design (RCBD) where treatments of seeds soaked for different durations of 6 hrs, 12 hrs, 24 hrs, 36 hrs, 48 hrs and non-soaked seeds (control) were assigned randomly to the experimental units. The study revealed that seed soaking had no different effect on plant establishment, seed yield and quality of French bean compare to non-soaking seed.

Yield and quality of garden pea seed as influenced by sowing dates and varieties

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2015-16 to find out the effect of sowing dates and varieties on yield and quality of garden pea seed**.** Garden Pea seeds of two varieties viz., BARI Motorshuti-1 and BARI Motorshuti-3 were sown at 10 days interval such as 20 October, 30 October, 10 November and 20 November. Significantly highest seed yield (1.96 t/ha) was found in 20 November sowing. Among the varieties, BARI Motorshuti-1 produced significantly higher seed yield compared to BARI Motorshuti-3. Interaction effect was found significant and maximum seed yield 2.0 t/ha was noted on 20 November sowing of BARI Motorshuti-1. BARI Motorshuti-3 at 20 November showed better seed quality in terms of germination and vigor index.

18 VERTEBRATE PEST

Development of management package against squirrel damage in coconut trees

The experiment was conducted at Fruit Research Centre, Binodpur, Rajshahi during December 2015 - May 2016 to find out the suitable management tactics to repel squirrels from the coconut trees.. There were 4 treatments viz, T_1 = Wrapping 2.5 feet metal sheet around the tree trunk 6 feet above from the ground, T_2 = Hanging of human hair on the tree trunk, T_3 = spraying repellent made by onion + hot chilli + green chilli and T_4 = Untreated control. The experiment was laid out following RCB design with 4 replications. One coconut tree (9-10 years) was treated as one replication. Metal sheets were placed on the tree trunk 6 feet above from the ground by surfing nails into the tree trunk with the hammer. Human hair (50g) collected from salons was hanged on the tree trunk with the help of nylon net bags. Human hair was changed every 15 days' interval. Homemade squirrel repellent {onion (10g) + hot chilli (5g) + green chilli (5g)} was applied to the tree canopy with the help of foot pump at 7 days' interval. Plant to plant distance was around 6 meter apart from one another. Number of squirrels moving toward the tree, number of squirrels reaching on the top of the canopy, number of damaged fruits, number of healthy fruits and per cent fruit damage caused by squirrel were recorded up to 7 days after the application of the treatments of every interval.

The number of squirrels reaching on the tree canopy numerically and significantly differed among the treatments. All the treatments significantly reduced the squirrel infestation and repelled the squirrels from the trees over the control. No damaged coconut fruit was found (0.00) in wrapping metal sheet treated trees. Hanging of human hair treated trees showed less infestation next to metal sheet treated trees (30.07%) followed by homemade spray application (onion + hot chili + green chili) (34.04%). Capsaicin (the active ingredient in hot peppers) has been found to repell the squirrels.

Survey on bird damage in sprouting wheat in different wheat growing areas of Bangladesh

The study was conducted in the wheat growing area of Thakurgaon region during 2015-16 planned to know the extent of damage by birds in sprouting wheat. The Questionnaire survey was conducted in 3 villages from the Thakurgaon sadar and 2 villages from Baliadangi upazila in Thakurgaon district. Questionnaire survey on bird damage in sprouting wheat in farmers field was conducted among randomly selected 32 farmers from Thakurgaon sadar and 28 farmers from Baliadangi upazila in Thakurgaon district. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different question such as size of farm, damage caused by bird species in sprouting wheat, intensity of bird damage, nature of damage, stage of damage, damage time of day, problem of bird in ripening stage and different control methods used by the farmers etc. This survey was conducted at the time of sowing season of wheat during 2015. The farmers who actually worked in the farms during these seasons are selected for the interview. It was an important tool for understanding the extent of awareness about birds as part of the agro eco-system. Learning the traditional and modern techniques practiced by farmers and workers in order to avoid the loss and their effectiveness. All questionnaire sheets were carefully filled up, compiled, summarized and presented in tabular form. Direct visual observation of bird damage was done in the farmers' fields after sowing wheat seeds.

From the study it was revealed that birds were the major problems in sprouting wheat. Many birds caused damage to sprouting wheat such as common myna, pied myna, house crow, jungle crow, house sparrow, rock dove, pigeon etc. Bird problems in sprouting wheat were acute and most of the farmer opined that birds were serious problem during sowing time of wheat. Maximum farmers expressed their opinion that pied myna (100%) was the most serious pest in sprouting wheat followed by common myna (83%) and jungle crow (56%). Jungle crow was also serious problem near the urban area. Farmers (100%) opined that birds are major problems in sprouting wheat. Pied myna, common myna and crow were the most serious pest in wheat. Maximum bird damage occurred between 10-15 days and damage ranges was from 30–50 percent. Birds were not serious problem in ripening stage of wheat. Farmers used different control techniques for controlling bird and repelling and use of different chemicals were the common techniques.

Development of suitable bird repellent (sub-lethal dose) for repelling bird in sprouting wheat in laboratory

The experiment was conducted at the aviary of Vertebrate Pest Division, BARI, Gazipur to repel birds from sprouting wheat using different repellent. Two repellent (Provax-200 and Copper oxychloride) were evaluated as bird repellents in caged feeding trials. Blue rock pigeon were used as test birds. The bird was caged individually provided food and water *ad libitum*. Individual cage feeding trials were conducted in an aviary, where individual cage (45x30x40 cm3) were visually isolated and equipped with waters. Food was applied in plastic food cups with a circular opening in the top. Four days before starting of the trial, we removed birds from their holding cages, weighed them, and randomly assigned each to a test cage. Test groups of 5 birds each were formed by randomly assigning birds to receive both untreated wheat and wheat treated with provax 0.4% and copper oxy chloride 0.3%. During the 4-day acclimation period, we provided birds with a mixture of seed diet. Following acclimatization, there was a 4-day pretreatment period, and a 4-day treatment period. During pretreatment, each bird offered 20 g of untreated wheat seed. During the treatment phase, birds received treated 20g wheat and 20g untreated wheat. Aluminum trays suspended from test cages under each cup were used for collecting spillage. The spillage information was used to estimate the proportion of wheat seed removed from the cups that was actually eaten. Cups containing test food not exposed to birds were put in vacant cages to determine mass changes due to moisture. After 7 hr, test food was removed food again provided for maintaining the birds. Contents of test food cups were weighed and determined the consumption by subtraction after appropriate adjustments for spillage and moisture gain. We randomized the positioning of treatments within individual cages on the first day and alternated positioning on subsequent days of the test to overcome potential side preferences. After the final treatment day, test birds were reweighed and released. The bird that had consumed $\leq$ 50% of the amount offered was considered repelled. Descriptive statistics (mean and SE) were used to illustrate differences in food consumption between treated and untreated groups.

For repellency teste, blue rock pigeon discriminated between untreated and treated wheat during preference testing. Provax-200 and copper oxychloride treated wheat seed consumption was lower than the untreated wheat seed consumption. On average, blue rock pigeons consumed 16.87($\pm$2.57) g per bird per day in untreated wheat and 1.475 ($\pm$1.37) g per bird per day in wheat treated with Provax. The average consumption of copper oxychloride treated wheat seed was 1.57g and untreated seed was 9.53g which was significantly higher than the copper oxy chloride treated wheat seed. In repellency test provax-200 exhibited the better repellency than copper oxychloride.

Study of rodent and bird pests status and their damage severity at BARI research field and stores

Rodent and bird pests status and their damage severity were studied at the field crops and stores of different divisions and the campus of Bangladesh Agricultural Research Institute, Gazipur, during 2014-2015 and 2015-16. Various kinds of vertebrate pests like rodent, squirrels, birds, jackals, their incidence, nature and extent of damage were recorded. The name of different species with numbers were also recorded and reported. The rat species were collected with the help of different types of live traps. The bird species were recorded in different crops by visual observation. Crop damage by vertebrate pests was estimated at vegetative, grain filling and maturity stages of the crop. Crop damage was estimated from the randomly selected per unit area and active burrow count method. In case of bird documentation, different bird species were recorded by visual observation method at germinating and maturity stages of the crop. The observations were made during 9:00 a.m to 5:00 p.m during the day at seven days intervals. The cropped area under study (rat burrows counting) ranged 400-1000 sqm. of different crops field.

Groundnut, wheat, kaon, barley, sunflower and maize seeds were found to damage at germinating stage by crows, pigeon, martin, bulbul etc. and these crops were also found to damage by parakeet, pigeon and jangle crow at the prematurity and maturity stages. Considerable rat damage (about 10%) was recorded in the wheat fields at the grains filling stage and potato field at the tuber formation stage. Jackfruits were found to damage by a number of crows at the ripen stage in this campus. Besides these, considerable amount of stores and laboratory goods were observed to damage by the rat. A number of jackal and dogs were also found to damage in vegetable plots. They damaged the crops by digging the soil.

Survey of squirrel damage in different fruits and vegetables in selected areas of Bangladesh

The observational survey work was conducted in the vertebrate Pest Division, BARI, Gazipur and in the different Regional Agricultural Research Stations (RARS) named Jessore Akbarpur, Moulvibazar, Hathazari, Chittagong, RHARS Khagrachari, RHARS Ramgarh, Regional Wheat Research Station Shyampur, Rajshahi, Fruit Research Station, Rajshahi, under Bangladesh Agricultural Research Institute (BARI), Gazipur. Observations were made on the fruit trees like mango, coconut, jackfruits, litchi, guava, sapota, ber, bael, tamarind and other fruit trees and forest wood trees. Twenty fruit trees were observed for squirrel damage in each varieties and locations. The survey work was conducted among the farmers by prelisted questionnaires in different location through interview schedules. Sometimes different types of live traps were set in the research farms, fruit garden, farmers crop fields for collection of different species of squirrel. Squirrels pests damage of different crops in different fruit gardens were observed visually at 8 -12 a.m. and 3-5 p.m. and recorded. Percent fruit damage was recorded by counting healthy and infested fruits per tree. Data were recorded in November to March, 2015 and 2016 at 30 days intervals. Incidence, nature of damage and extent or amount of damage by the different vertebrate pests were also observed carefully and recorded per plant basis.

A considerable number of stripped squirrels (*Funambulus pennanti*) (1.5-2/plant) were observed to damage mango, coconuts, jackfruits, litchi, guava, sapota ber, bael, tamarind and citrus fruits in the garden in RARS Jessore, ARS Daulatpur and Fruit Research Satation Rajshahi. These fruits were also damaged by a good number of brown squirrels (*Callosciurus pygerythrus* G)(0.5-1.50/plant) in the RARS Akbarpur, Hathazari, Chittagong, Khagrachari, Ramgarh. But brown squirrels were found to damage in mango, sapota and Jamrul. in Daulatpur in 2016. The maximum damage of fruits (about 5-10%) caused by the squirrels were observed during April-June at premature and mature stage of the fruit.

Use of reflecting ribbon as a pest birds repellant in broccoli

The study was carried out in the research field of Plant Genetic Resources Centre (PGRC) field, BARI during 2015-2016 for repelling birds using reflective ribbon. For study the reflectors ribbons were used as mechanical repellant against pests bird. The broccoli plots measuring 20m x 3m were selected to install the reflector ribbons as pest birds repellent. The study was laid out following RCBD design with three dispersed replications. Variety was BARI broccoli -1 and the treatments were multicolored ribbon, silver colored ribbon and control (without ribbon). Broccoli was planted on November,25 2015 maintaining spacing 60cm x 50cm and fertilizer doses were urea 260 kg/ha, TSP 150 Kg/ha, MOP 100kg and gypsum 80 kg/ha of land. The ribbons were set on one month after planting. Reflecting ribbons were tied up over the crops longitudinally and supported by bamboo stick and plastic rope. Height of the reflector ribbons was given special consideration because too high and too low reflectors had significant effect on visiting bird pests. The reflecting ribbon erected about two feet above the crop was found to give better results. Number of pest birds (red vented bulbul) visiting the research fields of broccoli during the period of using Reflector ribbon (mechanical repellents) was counted.

The results showed that reflecting ribbon was the best bird pest repellent device. The lowest number of birds visited (3.8 bird/plot) and lowest damage (6.5%) was recorded on multicolored ribbon compared to control (without ribbon) (12bird/plot and 15% damage) treatment. Higher curd weight of broccoli was also recorded in multicolorede ribbon (460g/plant) than control (305g/plant). The multicolored ribbon was more effective than the silver colored ribbon.

Comparative study of rat damage in bed planting, line sowing and broadcasting wheat in Rajshahi region

A comparative study on rat damage in bed planting, line sowing and broadcasting methods of cultivation was conducted in wheat growing area at Chargat and Godagari upazilla under Rajshahi district during 2015-16. The study was done in two ways i) Questionnaire Survey ii) Rat damage estimation by counting cut and uncut method. A questionnaire survey on rat problem in farmer's wheat field was conducted among randomly selected 35farmers from Chargat and 25 farmers from Godagari upazila in Rajshahi district. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different question such as size of farm, damage caused by the rats, intensity of rat damage in bed planting and other planting method, different control methods used by the farmers etc. All questionnaire sheets were carefully filled up, compiled, summarized and presented as well. In cut and uncut method, ten plots in each upazilla were randomly selected. In each plot ten samples were taken. The data from these ten samples were used for calculating the damage in each plot as percentage. Very large or very small plots were not selected for sampling data. Ten samples along were selected in each plot. The distance between samples (between 3 to 5 steps) depends on the length of the diagonal. A sample closer than 3 meters (3 large steps) from any edge of the plot was not chosen. Each sample consists of 50 cm square frame in which all tillers, cut and uncut tillers were counted. These figures were put on a record sheet. The sampling frame in placed without looking, so that taking data would be real. After taking data from one plot next plots were selected randomly and repeated up to ten samples.

From the studies, it was revealed that about 75% farmers opined that the maximum rat damage (23%) occurred at the booting stage of wheat. Hundred percent farmers opined and also direct damage estimation revealed that the lowest (10-12%) damage was recorded in bed planting compared to two other cultivation methods. Rat damage was sometime higher in bed planting than other conventional method. This situation depends on the rat infestation in previous crop.

19 POSTHARVEST TECHNOLOGY

Storage stability of processed ginger paste

Good quality ginger rhizomes (BARI Ginger-1) were collected form Spices Research Centre and used in this study. The ginger rhizomes were broken into pieces to expose the crevices and then washed in running water to remove the adhering mud. Again, the cleaned rhizomes were scraped with a knife to remove dirt as well as spoiled portion. The ginger rhizomes were peeled cut and make paste using grinder then hold at room temperature for 1 hr in covered container to facilate enzymatic action for flavor and color development. The pastes were treated with 0%, 3%, 6%, 9%, and 12% common salt and added citric acid 0.4%. The paste was come down and adjusted to P^H level around 4.0. The paste was thermally processed at 100^0C for 20 min in water bath and poured immediately in glass bottle and plastic container according to the treatments used in this study. Then, the paste with containers was stored at room temperature (25-30^0C). The physicochemical parameters and microbial test were carried out to examine the quality of the products were studied during storage.

Microbiological Analysis

Enumeration of coliforms, mesophilic aerobes and yeasts and molds were done by pour plate and spread plate method following the procedure of the International Commission on Microbiological Specifications (ICMSF, 1992). Violet red bile agar for coliform bacteria, plate count agar (PCA) for mesophilic aerobes and potato dextrose agar (PDA) for yeast and molds procured from Himedia, India were used. Ten grams of ginger garlic paste sample were weighed in duplicates into 90 mL of 0.1% peptone water aseptically, homogenized and serial dilution was carried out. One milliliter of the appropriate dilution of the sample was taken in sterile Petri plates and 15 mL of respective agar maintained at 45C were poured into plates and allowed to solidify. Set plates were incubated at 37C for 48 h and colony count was taken after 24–48 h of incubation for bacteria. The potato dextrose plates for yeasts and molds were incubated at 27C for 3–4 days and colony count was recorded. All tests were carried out in duplicate and the average mean values are reported.

Results and Discussion

The process ginger paste was stored at 25^0C control temperature condition for four months in year of 2015-2016. The experiment was conducted last two years and data were analyzed. The interactive results are shown in the following table.

Table1. Combined effects among the packaging materials (P), salt percentages (S) and duration of storage (D) on the quality parameters of processed ginger paste

Treatments	TSS (%)	P^H	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
$P_1S_1D_1$	7.80	6.85	0.15	19.20	49.75	13.21	66.54
$P_1S_1D_2$	7.30	6.90	0.13	19.01	45.75	15.05	70.02
$P_1S_1D_3$	6.00	7.20	0.12	18.90	42.53	20.31	76.33
$P_1S_1D_4$	5.40	7.50	0.11	18.56	40.41	21.97	78.95
$P_1S_1D_5$	4.20	7.80	0.10	18.54	36.45	22.32	80.04
$P_1S_2D_1$	7.10	4.20	0.36	24.05	55.12	21.89	79.15
$P_1S_2D_2$	7.80	4.20	0.32	23.89	53.32	23.81	80.36
$P_1S_2D_3$	8.00	4.34	0.23	22.68	48.09	26.31	83.33
$P_1S_2D_4$	8.10	4.30	0.29	22.56	46.54	28.19	84.01
$P_1S_2D_5$	8.10	4.40	0.270	22.40	40.12	22.17	85.46
$P_1S_3D_1$	11.90	4.15	0.42	25.30	61.33	24.51	81.77
$P_1S_3D_2$	11.70	4.16	0.40	24.85	57.71	25.48	82.90
$P_1S_3D_3$	12.20	4.22	0.37	24.01	55.52	26.26	84.11
$P_1S_3D_4$	12.30	4.26	0.35	23.70	54.75	28.24	85.36
$P_1S_3D_5$	12.40	4.27	0.30	23.15	52.89	22.07	86.36
$P_1S_4D_1$	13.40	4.10	0.47	28.19	66.94	26.43	83.92
$P_1S_4D_2$	13.20	4.18	0.45	27.65	63.65	27.32	85.06
$P_1S_4D_3$	14.50	4.18	0.44	27.54	61.02	27.89	86.47
$P_1S_4D_4$	15.10	4.20	0.42	26.85	58.76	28.34	86.96
$P_1S_4D_5$	15.60	4.22	0.40	25.90	57.45	22.01	88.02
$P_1S_5D_1$	17.30	4.00	0.51	29.46	71.65	28.36	85.75
$P_1S_5D_2$	17.70	4.10	0.49	29.04	69.79	29.28	86.54
$P_1S_5D_3$	18.60	4.15	0.47	28.45	68.56	31.08	87.55
$P_1S_5D_4$	18.80	4.20	0.45	27.70	65.76	32.14	88.31
$P_1S_5D_5$	19.50	4.20	0.44	27.44	63.76	22.00	88.59
$P_2S_1D_1$	7.60	6.85	0.15	19.40	49.75	13.21	66.54
$P_2S_1D_2$	6.00	6.88	0.12	19.31	47.50	15.96	71.70
$P_2S_1D_3$	4.20	7.10	0.11	19.34	43.34	18.84	75.96
$P_2S_1D_4$	3.30	7.30	0.10	18.60	42.34	21.66	79.22
$P_2S_1D_5$	2.90	7.60	0.09	18.57	38.86	22.29	83.00
$P_2S_2D_1$	7.10	4.14	0.36	24.25	55.12	21.89	81.74
$P_2S_2D_2$	7.20	4.17	0.32	23.76	54.74	23.43	75.82
$P_2S_2D_3$	7.40	4.26	0.29	22.76	50.12	26.10	83.68
$P_2S_2D_4$	7.60	4.28	0.26	22.58	48.56	28.06	85.02
$P_2S_2D_5$	7.70	4.40	0.25	22.42	42.23	22.10	86.05
$P_2S_3D_1$	11.90	4.13	0.42	25.50	61.33	24.51	83.92
$P_2S_3D_2$	11.90	4.14	0.39	24.97	58.36	25.31	84.62
$P_2S_3D_3$	12.10	4.20	0.36	24.06	56.08	26.00	86.05
$P_2S_3D_4$	12.80	4.23	0.35	23.75	55.01	27.68	86.62
$P_2S_3D_5$	13.10	4.25	0.33	23.23	53.06	22.05	87.80
$P_2S_4D_1$	13.40	4.03	0.47	28.50	66.94	26.43	83.92

Treatments	TSS (%)	P^H	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
$P_2S_4D_2$	14.90	4.12	0.44	27.77	64.22	26.85	85.06
$P_2S_4D_3$	15.10	4.16	0.43	27.57	61.65	27.16	86.47
$P_2S_4D_4$	15.50	4.18	0.41	26.90	59.45	28.05	86.96
$P_2S_4D_5$	16.50	4.20	0.39	25.96	56.90	22.00	88.02
$P_2S_5D_1$	17.30	4.00	0.51	29.26	71.65	28.26	85.75
$P_2S_5D_2$	17.50	4.10	0.48	28.87	69.30	29.11	86.40
$P_2S_5D_3$	18.60	4.10	0.45	28.02	68.22	30.17	87.40
$P_2S_5D_4$	18.60	4.10	0.43	27.67	65.01	31.10	88.23
$P_2S_5D_5$	19.40	4.20	0.42	27.04	63.06	21.99	88.47
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.162	0.162	0.162	0.198	0.294	0.162	2.87

In control conditions the microbial growth was seen using different packaging materials. But the processed ginger paste was kept and stored up to 4 months in glass container (GC) that gave best results with no presence of microbial growth although different salt percentages were added. Hence, it was processed and stored in plastic container (PC). No presence of bacteria up to 1 month at 25^0C control temperature condition when 3% and 12% salt were added.

Effect of drying on postharvest quality of jute leaf

The jute seed was collected from BINA, Mymensingh. Then the seeds were sown in our laboratory field. When the leaf age was 40 days, then it was collected dried. The Jute (Binapatshak-1) leaf was collected from the laboratory field.

Drying methods

The drying of Jute leaf was conducted using the two methods of Mechanical dryer and Freeze dryer.

Mechanical dryer

Cabinet dryer, Model OV-165 (Gallen Kamp Company) was used for dehydration of jute leaf. The dryer consists of a chamber in which trays of products could be placed. Air was blown by a fan pass through a heater and then across the trays of products to be dried. The velocity of air was recorded (0.6 m/sec) by an Anemometer.

To conduct drying experiments, the jute leaf was separated from plant by hands and samples were taken for determination of initial moisture content. Fresh jute leaf at constant loading density (0.5 kg/ft^2) were placed in trays in the drier and drying commenced in the drier at a constant air velocity (0.6 m/sec) and at a specific air dry bulb temperature (45, 55 and 65°C). The drying time required for 45, 55 and 65°C temperatures as 60, 48 and 36 hours, respectively. Weight loss was used as a measure of the extent of drying.

Freeze drying

Freeze drying is the gentlest process for drying products. It is based on the physical phenomenon of sublimation, i.e. is the direct conversion form solid to gaseous state. The frozen product is dried under vacuum without thawing. Freeze drying was done by using CHRIST Alpla 1-4 LED model machine. There were two main processes one is main drying and another is final drying. In main drying time was 48 hour, temperature -56^0 C and vacuum was 0.018 milibar. In final drying time was 48 hours, temperature was -76^0 C and vacuum was 0.001 milibar.

Results and Discussions

The cabinet dried and freeze dried jute leaf were stored in polythene packets at ambient temperature condition. For the time being, the chemical compositions of fresh and dried jute leaf were analyzed for two months with one-month interval. The dry matter percentage, TSS, P^H, acidity, vitamin C, β-carotene and color parameters that are typically assessed for fresh and dried jute leaf for each month interval. The experimental data were analyzed and presented in the following section.

Table 1 showed the nutrient contents and external color parameters of fresh jute leaf for the year of 2015-2016. Initially less temperature gives high dry matter percentages, then decreased but in freeze dried product gives high values as compared to 55^0C and 65^0C temperature dried at cabinet dryer.

Table 1. Nutrient contents and external color parameters of fresh jute leaf

TSS (%)	pH	Acidity (%)	Vitamin C (mg/100g)	β- carotene (μg/100g)	Color co-ordinates		
					Lightness	a*	b*
4.20	5.99	0.13	85.00	80.56	48.22	-6.96	23.34

Table 2. Changes of dry matter percentages of dried jute leaf

Treatments	Dry matter %		
	Storage period, months		
	0	**1**	**2**
T_1= cabinet drying at 45^0C	18.63	-	-
T_2= cabinet drying at 55^0C	16.17	-	-
T_3= cabinet drying at 65^0C	15.48	-	-
T_4= freeze drying	16.40	-	-

In the Table 3 depicted p^H and acidity contents of dried jute leaf stored in packets as powder formation for the year of 2015-2016. The initially the fresh jute leaf p^H was 5.99 but it increased at 45^0C then decreased after increasing more temperature, freeze drying showed highest p^H values. The maximum p^H was observed in treatment T_4 (6.60) followed by treatment T_1 (6.55) and the lowest was in treatment T_3 (6.25) immediate after powder formation whereas the height p^H was observed in treatment T_4 (6.63) followed by treatment T_1 (6.62) and the lowest was in treatment T_3 (6.42) after 1 month of storage. On the other hand, after 2-month storage same changes were observed. The initial acidity content of fresh jute leaf was 0.13 (Table 1), the highest acidity was observed in treatment T_4 (1.21) followed by treatment T_1 (1.19) and the lowest was in treatment T_3 (1.07) immediate after powder formation whereas the maximum acidity was observed in treatment T_4 (1.28) followed by treatment T_1 (1.26) and the lowest was in treatment T_3 (1.10) after 1 month of storage. Moreover, after 2 months' storage the highest acidity was observed in treatments T_1 and T_4 and the lowest acidity was found in treatment T_3 (1.11).

Table 3. Changes of P^H and acidity contents of dried jute leaf

Treatments	P^H			Acidity (%)		
	Storage period, months					
	0	**1**	**2**	**0**	**1**	**2**
T_1= cabinet drying at 45^0C	6.55	6.62	6.65	1.19	1.26	1.42
T_2= cabinet drying at 55^0C	6.45	6.49	6.51	1.15	1.17	1.19
T_3= cabinet drying at 65^0C	6.25	6.42	6.43	1.07	1.10	1.11
T_4= freeze drying	6.60	6.63	6.65	1.21	1.28	1.42

Vitamin C (mg/100g) and β- Carotene (μg/100g) contents of dried jute leaf stored in packets as powder formation are shown in Table 4. Initially the fresh jute leaf vitamin C was 85.00 mg/100g but it became decreasing after increasing storage duration as well increasing more temperature, at the same time the freeze-dried product showed highest values of vitamin C. The maximum vitamin C was observed in treatments T_1 and T_4 (6.60 mg/100g) followed by treatment T_2 (39.37 mg/100g) and the lowest was in treatment T_3 (29.53 mg/100g) immediate after powder formation whereas the highest p^H was observed in treatment T_4 (47.33 mg/100g) followed by treatment T_1 (44.44 mg/100g) and the lowest was in treatment T_3 (19.19 mg/100g) after 1 month of storage. On the other hand, after 2-month storage same changes were observed. The initial β- carotene content of fresh jute leaf was 80.56 μg/100g (Table 1), the highest β- carotene was observed in treatment T_4 (116.21 μg/100g) followed by treatment T_1 (110.38 μg/100g) and the lowest was in treatment T_2 (105.47 μg/100g) immediate after powder formation whereas the maximum β- carotene was observed in treatment T_1 (93.74 μg/100g) followed by treatment T_4 (92.45 μg/100g) and the lowest was in treatment T_3 (80.40 μg/100g) after 1 month of storage. Hence, after 2 months' storage the highest β- carotene was observed in treatment T_4 (82.17 μg/100g) and the lowest β- carotene was found in treatment T_3 (60.27 μg/100g).

Table 4. Changes of Vitamin C (mg/100g) and β- Carotene (μg/100g) contents of dried jute leaf

Treatments	Vitamin C (mg/100g)			β- carotene (μg/100g)		
	Storage period, months					
	0	**1**	**2**	**0**	**1**	**2**
T_1= cabinet drying at 45^0C	49.21	44.44	34.44	110.38	93.74	80.54
T_2= cabinet drying at 55^0C	39.37	28.28	26.28	105.47	87.77	67.59
T_3= cabinet drying at 65^0C	29.53	19.19	23.99	89.24	80.40	60.27
T_4= freeze drying	49.21	47.33	37.33	116.21	92.45	82.17

Color is an important factor in the perception of dried jute leaf quality. The changes in the leaf color were monitored by estimating lightness (L), chromaticity co-ordinates a^* and b^* during cabinet drying at 45^0C to 65^0C temperatures and in freeze drying. The values are presented in the Table 5 and it represented that the intensity of light blue green color of the jute leaf were gradually increased with extend the temperature period and turned blue green as evidence by increasing values of L and changing values of a^* and b^* accordingly. The jute leaf under the cabinet drying at 45^0C condition (T_1) to freeze drying (T_4) represented a slower change in the leaf color as indicated gradually decreased in L for cabinet drying from temperature of 45 to 65^0C and changing the values of a^* and b^* accordingly dried for 48 hrs.

Table 5. Effect of drying on the external color changes of dried jute leaf

Treatments	**Storage period, months**								
	0			**1**			**2**		
	Color co-ordinates								
	L	a*	b*	L	a*	b*	L	a*	b*
T_1= cabinet drying at 45^0C	39.78	-5.54	21.13	36.42	-4.60	17.45	35.02	-4.10	16.17
T_2= cabinet drying at 55^0C	31.22	-4.12	15.72	25.90	-3.15	14.40	23.11	-3.05	12.11
T_3= cabinet drying at 65^0C	25.60	-3.40	11.20	24.74	-2.37	10.12	22.12	-1.41	9.66
T_4= freeze drying	41.98	-8.98	22.41	38.14	-7.10	17.98	35.12	-4.11	13.98

Drying of fresh product and stored in any forms is an old and well-established practice for preserveing food for long time. Although this is the final year investigation, for time being here presented a two months storage results and it is concluded from the above findings that the jute leaf was stored in polyethylene packet after drying at 45^0C using cabinet dryer at the same time freeze dryer is an alternate option to preserve jute leaf powder for prolong storage. Considering the financial involvement, cabinet dryer is the best option for drying jute leaf because of cabinet drying system is moderately cheap.

Effect of blanching on the quality and storage stability of pea

Pea (*Pisum sativum*) was collected from the local market of Gazipur and transported to the postharvest laboratory of BARI, Gazipur. Pea used in this experiment was greenish and firm and the physical appearance was better. Sound, mature and fresh pea which was free from diseases and visual defects were identified and discard. The peas were hand shelled. Water blanching was performed in hot water bath at temperature 80^0C in different duration of 1, 3, 5, 7 minutes. Then, cool the product in distilled water and packed in high density polythene where vacuum packing was done. Finally, the product was stored at the laboratory deep freeze (-18^OC) available for homestead use. The experiment was started from the month of February in this year and the products were stored for the next 4 months and the shelf life studies were continued after 1 month interval.

Treatments

T_1 = Control

T_2 = blanching at 80^0 C for 1 min

T_3 = blanching at 80^0 C for 3 min

T_4 = blanching at 80^0 C for 5 min

T_5 = blanching at 80^0 C for 7 min

Result and discussion

The process peas were stored in deep freeze for four months. The chemical compositions were analyzed in every month. The experimental data were analyzed and presented in the following section. Dry matter percentages, TSS, P^H, acidity, vitamin C, β- carotene are the quality parameters and external color that are typically assessed for fresh products, immediately after blanching and after a given storage period.

Table 1 showed that the dry matter percentages (DM %) and TSS contents of fresh and blanched pea at different treatments for the year of 2015-2016. The DM% of blanched peas was decreased when the blanching time and temperature were increased; the DM% rates were gradually decreased after storage time increases. But, the increase rates were investigated slower after three-month storage. In the fresh pea, the initial TSS contents were found 12.10 but it was decreased after prolonged storage as well as blanching with different time. The peas were blanched at 80^0C with 7 minutes up to two months' storage showed reasonable values of TSS. The acidity contents of blanched peas were decreased and P^H contents were increased after increases the blanching time, these were continued at the same rate after storage time increased (Table 2). The products were blanched at 80^0C with 7 minutes up to three months' storage gives suitable values of acidity content. The vitamin C contents of fresh peas were found 40.10 mg/100g, but it was decreased after blanching with prolonged storage. The changes in vitamin C contents of processed peas were decreased after increased blanching time; and it was decreased at the same rates after storage period increased (Table 3). Whereas, initially the β- carotene contents of fresh peas were found 45.65 μg/100g but, it was decreased at blanched condition. At blanching, the changes of β- carotene contents were decreased after increased the blanching time; these were decreased at the same rate after storage at certain duration. Generally, blanching produces a decrease in the nutritional value of foods. Nutrients leach out from the product especially during water blanching. In addition, vitamins are degraded by heat. Vitamin C (ascorbic acid) is, by far, the most commonly assayed nutrient in blanching probably because its high solubility and heat susceptibility make it a conservative indicator of nutrient retention.

Table 1. Changes of dry matter and TSS percentages of fresh and blanched pea

Treatments	Dry matter percentages					TSS (%)				
	Storage period, months									
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
T_1= Control	30.53a	29.69a	29.60a	28.60a	27.69a	12.1a	9.1a	8.6a	5.2a	4.5a
T_2= 80^{0}C, 1 min	30.21b	28.31b	27.26c	27.14b	27.09b	11.4b	8.6b	7.8b	5.1a	4.4ab
T_3= 80^{0}C, 3 min	29.46c	27.87c	27.65b	26.76c	26.56c	10.8c	7.9c	7.4c	4.9b	4.3bc
T_4= 80^{0}C, 5 min	28.13d	26.37d	26.17d	25.47d	24.65d	10.2d	7.7d	7.3c	4.5c	4.2c
T_5= 80^{0}C, 7 min	26.81e	25.47e	25.22e	24.57e	24.13e	9.5e	7.5e	6.9d	4.3d	3.9d
C.V. (%)	0.34	1.91	0.37	0.38	0.38	0.93	1.23	1.32	2.08	2.35

Means in the same column followed by different letters differs (P<0.05) according to DMRT

Table 2. Changes of P^H and acidity contents of fresh and blanched pea

Treatments	P^H					Acidity (%)				
	Storage period, months									
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
T_1= Control	7.08b	7.13a	7.18	7.21	7.24	0.19a	0.18a	0.17a	0.16a	0.15a
T_2= 80^{0}C, 1 min	7.12ab	7.16	7.20	7.22	7.26	0.18a	0.17a	0.16a	0.15a	0.14a
T_3= 80^{0}C, 3 min	7.20ab	7.22	7.26	7.27	7.30	0.16b	0.15b	0.14b	0.13b	0.12b
T_4= 80^{0}C, 5 min	7.25ab	7.28	7.30	7.31	7.33	0.15b	0.14b	0.13bc	0.12bc	0.12b
T_5= 80^{0}C, 7 min	7.29a	7.31	7.33	7.34	7.36	0.13c	0.12c	0.12c	0.11c	0.11b
C.V. (%)	1.39	1.41	1.38	1.38	1.37	6.17	6.58	6.94	7.46	7.81
LSD	0.182									

Means in the same column followed by different letters differs (P<0.05) according to DMRT

Table 3. Changes of Vitamin C (mg/100g) and β- Carotene (μg/100g) contents of fresh and blanched pea

Treatments	Vitamin C (mg/100g)					β- carotene (μg/100g)				
	Storage period, months									
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
T_1= Control	40.10a	30.75a	27.10a	22.75a	20.45a	45.65a	38.45a	34.15a	30.30a	27.25a
T_2= 80^{0}C, 1 min	34.40b	28.30b	25.20b	20.50b	17.20b	41.35b	36.40b	32.35b	29.30b	24.18b
T_3= 80^{0}C, 3 min	32.30c	26.20c	23.50c	19.80c	15.20c	38.10c	32.45c	28.40c	25.35c	21.15c
T_4= 80^{0}C, 5 min	29.30d	23.10d	20.80d	17.70d	14.50d	36.30d	28.48d	24.48d	21.42d	19.35d
T_5= 80^{0}C, 7 min	24.40e	19.25e	16.50e	14.30e	11.60e	34.24e	25.38e	22.58e	18.47e	16.34e
C.V. (%)	0.31	0.39	0.44	0.53	0.63	0.26	0.31	0.35	0.40	0.46

Means in the same column followed by different letters differs (P<0.05) according DMRT

Color is an important factor in the perception of pea quality. The changes in the pea color were monitored by estimating lightness (L), chromaticity co-ordinates a^* and b^* during storage at deep freeze. The values are presented in the Table 4 and it represented that the intensity of light bluish color of the pea were gradually increased with extend the storage period and turned light green as evidence by increasing values of L and changing values of a^* and b^* accordingly. The processed pea under the control condition (T_1) to 80^{0}C temperature with blanching time of 7 minutes (T_5) represented a slower change in the pea color as indicated less gradually decreased in L and changing the values of a^* and b^* accordingly after 3 months of storage.

Blanching inactivates a portion of the enzymes and effects color and texture. Blanching the vegetables before freezing impedes enzyme action during storage time in the freezer and this means that the deterioration of the vegetable was kept at a minimum and that vegetables will emerge from the freezer in the same condition as they entered. As such a sole method of preservation but as a pretreatment, this was normally carried out between the preparation of raw material and latter operations. There were different types of enzymes and their specific reactions that were responsible for flavor and color changes are not positively known. Most enzymes are inactivated rapidly as temperature rises to 80^{O}C using 7 min blanching time. Catalase and peroxidase are two enzymes that resist heat inactivation and lose their reactivity in the range of importance for stabilizing frozen vegetables. These two enzymes have widely used to tell whether or not blanching has been adequate. Peroxidase was the more heat resistance of the two. As a result, the absence of residual peroxide activity would indicate that the other less heat resistant enzymes was also destroyed. Peroxidase and catalase inactivation time of enzyme for steam blanching of peas are presented in Table 5. The blanching effect (temperature and time) and quality parameters are tested in the year of 2015-2016, it would be concluded that the treatment T_5 (blanching temperature 80^0C and time 7 minutes) with three-month storage was found suitable. Therefore, peas can be stored at deep freeze using the above blanching condition for the three months.

Table 4. Effect of blanching on the external color changes of fresh and blanched pea

Treatments	Storage period, months								
	0			**1**			**2**		
	Color co-ordinates								
	L	a*	b*	L	a*	b*	L	a*	b*
T_1= Control	53.10a	-71.74e	-5.96d	46.62a	-5.79b	7.69c	45.88a	-5.31c	26.68a
T_2= 80^0C, 1 min	47.98b	-67.62d	-5.08c	43.05b	-6.71d	7.56c	32.82d	-6.55e	22.18b
T_3= 80^0C, 3 min	42.77c	-58.67c	-4.56b	42.05c	-6.03c	9.27a	34.92b	-4.88b	18.92c
T_4= 80^0C, 5 min	40.69d	-57.74b	-4.52b	38.01d	-6.00c	8.44b	33.45c	-5.88d	15.89d
T_5= 80^0C, 7 min	38.11e	-56.02a	-4.32a	34.78e	-5.32a	8.36b	30.28e	-4.11a	12.93e
C.V. (%)	0.22	-0.16	-2.05	0.24	-1.68	-1.21	0.28	-1.87	1.61

Treatments	Storage period, months					
	3			**4**		
	Color co-ordinates					
	L	a*	b*	L	a*	b*
T_1= Control	40.10a	-4.95c	27.01a	39.10a	1.79a	27.95e
T_2= 80^0C, 1 min	31.78b	-5.88d	23.23b	31.13b	1.13b	28.70d
T_3= 80^0C, 3 min	30.72c	-4.08a	19.36c	28.43c	0.56c	31.72a
T_4= 80^0C, 5 min	29.75d	-4.70b	18.11d	28.30c	0.53c	31.16b
T_5= 80^0C, 7 min	28.32e	-3.98a	16.50e	26.49d	0.32d	30.59c
C.V. (%)	0.31	-2.12	0.48	0.33	17.13	0.36

Means in the same column followed by different letters differs ($P<0.05$) according to DMRT

Table 5. Inactivation time of enzyme for steam blanching of peas

Treatments	T_1	T_2	T_3	T_4	T_5
Peroxidase	+	+	+	-	-
Catalase	+	+	+	+	-

Note: T_1 = control; T_2= blanching at 80^0C 1 min; T_3= blanching at 80^0C 3 min; T_4= blanching at 80^0C 5 min; T_5= blanching at 80^0C 7 min

Blanching is an old and well-established practice in the food industry. Early technological improvements focused on increasing product quality. From the investigations, it was found that the dry matter percentages, acidity, P^H, β- carotene, vitamin C and TSS contents of frozen peas were reduced during blanching with longer storage periods. The study results showed that the frozen peas were stored well in deep freeze up to three months using blanching temperature of 80^0C and duration of 7 minutes.

Effect of chitosan coating on the quality and shelf life of papaya

Fresh matured papaya at the pre climacteric stage (nearly ripe) with green color were collected from the farmer's field of Pabna district and randomly selected for the experiment. The papaya was transported to the Postharvest Technology Division Laboratory of BARI, Gazipur in plastic crates, where it was sorted out to remove immature, misshaped, bruised, diseased and insect infested. The papaya was then washed, air-dried and treated with different percentages of chitosan solution.

Sample Treatment

Chitosan solutions were prepared by dissolving 1.0, 2.0, 3.0 and 4.0 g of chitosan in 100 ml distilled water containing 0.5 ml (v/v) of glacial acetic acid. The solution was heated and agitated constantly for 2 h. The p^H of the solution was adjusted to 5.6 with 1 N NaOH. The papaya was washed with chlorinated water (0.01%), prepared from 5% sodium hypochlorite, prior to coating treatments. The samples were allowed to air dry, after which they were randomly divided into five different treatments. Followed by drying, the papayas were dipped into different concentrations of chitosan for 1 min along with untreated control sample. The papayas were then air dried, kept in plastic shelf and stored at ambient condition (38^0C). The treatments were as follows:

Treatments

T_1 = Control

T_2 = 1% aqueous solution of chitosan

T_3 = 2% aqueous solution of chitosan

T_4 = 3% aqueous solution of chitosan

T_5 = 4% aqueous solution of chitosan

Result and discussion

The fresh and chitosan coated papayas were stored in plastic crates at ambient atmospheric condition. The chemical compositions were analyzed for ripening enhanced within 6 days intervals. Percentage weight loss, firmness, TSS, P^H, acidity, vitamine C, bita-carotine, and color are quality parameters that are typically assessed for fresh and chitosan coated papaya at 6 days intervals. The experimental data were analyzed and presented in the following section.

Table 1 shows the changes of weight loss of chitosan coated stored papaya for the year of 2015-2016. The maximum weight loss was observed in treatment T_1 (4.2%) followed by treatment T_4 (3.4%) and the lowest was in treatment T_3 (3.2%) after 6 days of storage whereas the maximum weight loss was observed in treatments T_1 and T_4 (7.7%) followed by treatment T_2 (6.7%) and the lowest was in treatment T_3 (5.3%) after 12 days of storage. On the other hand, after 18 days storage when the papaya was full ripened; the control condition (T_1) became spoilage and lowest weight loss was found in treatment T_3 (6.5%).

Table 1. Changes of weight loss of chitosan coated stored papaya

Treatments	% Weight loss			
	Storage period, days			
	0 (fresh)	6	12	18
T_1= Control		4.2	7.7	spoilage
T_2= 1% chitosan sol^n		3.3	6.7	9.33
T_3= 2% chitosan sol^n		3.2	5.3	6.50
T_4= 3% chitosan sol^n		3.4	7.7	10.11
T_5= 4% chitosan sol^n		3.3	6.5	10.31

In the Table 2 represented the firmness and TSS contents of fresh and chitosan coated stored papaya for the year of 2015-2016. The initially the fresh green papaya firmness was 20.05 kg-f/cm^2 but it was reduced after storage at different days of intervals. The maximum firmness was observed in treatment T_3 (16.04 kg-f/cm^2) followed by treatment T_4 (15.42 kg-f/cm^2) and the lowest was in treatment T_1 (12.91 kg-f/cm^2) after 6 days of storage whereas the maximum firmness was observed in treatment T_3 (14.70 kg-f/cm^2) followed by treatment T_4 (13.92 kg-f/cm^2) and the lowest was in treatment T_1 (10.04 kg/cm^2) after 12 days of storage. On the other hand, after 18 days' storage when the papaya was full ripened; the control condition (T_1) became spoilage and lowest firmness was found in treatment T_3 (9.52 kg-f/cm^2). The initial total soluble solid (TSS) of fresh green papaya was 5.8, after development of full color the TSS was increased rapidly in all treatments except in control condition (T_1) it became spoilage after 18 days of storage. The highest TSS was observed in treatments T_3 and T_5 (7.2) followed by treatment T_4 (7.1) and the lowest was in treatment T_1 (6.2) after 6 days of storage. Almost similar results were found in all others treatments when it was stored in 12 and 18 days' storage.

Table 2. Changes of firmness (kg-f/cm^2) and TSS percentages of fresh and chitosan coated stored papaya

Treatments	Firmness (kg-f/cm^2)				TSS (%)			
	Storage period, days							
	0 (fresh)	6	12	18	0 (fresh)	6	12	18
T_1= Control		12.91	10.09	spoilage		6.2	7.4	spoilage
T_2= 1% chitosan sol^n		14.72	11.55	8.53		6.8	8.3	9.0
T_3= 2% chitosan sol^n	20.05	16.04	14.70	9.52	5.8	7.2	8.5	9.2
T_4= 3% chitosan sol^n		15.42	13.92	8.54		7.1	8.4	9.1
T_5= 4% chitosan sol^n		14.74	13.56	8.66		7.2	8.3	9.1

Table 3 depicted p^H and acidity contents of fresh and chitosan coated stored papaya for the year of 2015-2016. The initially the fresh green papaya p^H was 5.70 but it became increasing after color development at different days of storage intervals. The maximum p^H was observed in treatment T_5 (5.78) followed by treatments T_1 andT_4 (5.77) and the lowest was in treatments T_2 and T_3 (5.75) after 6 days of storage whereas the height p^H was observed in treatments T_1 (6.02) followed by treatment T_2 (5.86) and the lowest was in treatment T_3 (5.79) after 12 days of storage. On the other hand, after 18 days storage when the papaya was full ripened; the control condition (T_1) became spoilage and the second lowest p^H was found in treatment T_3 (6.05). The initial acidity of fresh green papaya was 0.26, after developing of full color the acidity became decreasing in all treatments except in control condition (T_1) it became spoilage after 18 days of storage. The highest acidity was observed in treatment T_2 (0.22) followed by treatments T_3 and T_4 (0.21) and the lowest was in treatments T_1 and T_5 (0.19) after 6 days of storage whereas the maximum acidity was observed in treatments T_1 (0.18) followed by treatment T_3 (0.17) and the lowest was in treatment T_4 (0.15) after 12 days of storage. On the other hand, after 18 days of storage when the papaya was full ripened, the control condition (T_1) became spoilage and the second lowest acidity was found in treatments T_3 and T_5 (0.13).

Table 3. Changes of P^H and acidity contents of fresh and chitosan coated stored papaya

Treatments	P^H				Acidity (%)			
	Storage period, days							
	0 (fresh)	6	12	18	0 (fresh)	6	12	18
T_1= Control		5.77	6.02	spoilage		0.19	0.18	spoilage
T_2= 1% chitosan sol^n		5.75	5.86	5.95		0.22	0.16	0.14
T_3= 2% chitosan sol^n	5.70	5.75	5.79	6.05	0.26	0.21	0.17	0.13
T_4= 3% chitosan sol^n		5.77	5.82	6.15		0.21	0.15	0.12
T_5= 4% chitosan sol^n		5.78	5.83	6.17		0.19	0.16	0.13

The changes in vitamin C and β- Carotene contents of fresh and chitosan coated stored papaya for the year of 2015-2016 are shown in the Table 4. Initially the fresh green papaya vitamin C was observed 28.00 mg/100g but it became increasing after color development at different days of storage intervals. The maximum vitamin C was observed in treatment T_3 (37.24 mg/100g) followed by treatment T_2 (37.12 mg/100g) and the lowest was in treatment T_1 (31.04 mg/100g) after 6 days of storage whereas the height vitamin C was observed in treatments T_3 (42.45 mg/100g) followed by treatment T_5 (41.56 mg/100g) and the lowest was in treatment T_2 (40.24) after 12 days of storage. On the other hand, after 18 days of storage when the papaya was full ripened, the control condition (T_1) became spoilage and the highest vitamin C was found in treatment T_3 (52.35 mg/100g). The initial β- carotene of fresh green papaya was 17.50 μg/100g, after developing of full color the acidity became increasing in all treatments except in control condition (T_1) it became spoilage after 18 days of storage. The highest β-carotene was observed in treatment T_3 (27.20 μg/100g) followed by treatments T_2 and T_4 (24.40 μg/100g) and the lowest was in treatment T_1 (22.80 μg/100g) after 6 days of storage whereas the maximum β- carotene was observed in treatment T_3 (38.60 μg/100g) followed by treatment T_5 (36.10 μg/100g) and the lowest was in treatment T_1 (32.00 μg/100g) after 12 days of storage. On the other hand, after 18 days storage when the papaya was full ripened; the control condition (T_1) became spoilage and the highest β- carotene was found in treatment T_3 (52.30 μg/100g).

Table 4. Changes of Vitamin C (mg/100g) and β- Carotene (μg/100g) contents of fresh and chitosan coated stored papaya

Treatments	Vitamin C (mg/100g)				β- carotene (μg/100g)			
	Storage period, days							
	0 (fresh)	6	12	18	0 (fresh)	6	12	18
T_1= Control		31.04	38.03	spoilage		22.80	32.00	spoilage
T_2= 1% chitosan sol^n		37.12	40.24	48.15		24.40	35.70	45.00
T_3= 2% chitosan sol^n	28.00	37.24	42.45	52.35	17.50	27.20	38.60	52.30
T_4= 3% chitosan sol^n		33.31	39.09	40.06		24.40	35.50	48.80
T_5= 4% chitosan sol^n		35.19	41.56	43.72		23.20	36.10	48.00

The changes in the papaya color were monitored by estimating lightness (L), chroma (C) and hue angle (H) during storage at ambient temperature using different percentages of chitosan coating. The values are presented in the Table 5 and it represented that the intensity of green color of the papaya were gradually increased with extend the storage period and turned yellow as evidence by increasing values of L and changing values of C and H accordingly. The papaya under the control condition (T_1) to 4% chitosan coating with 18 days storage (T_5) represented a slower changes in the papaya color as indicated more gradually increased in L and changing the values of C and H accordingly at 2% chitosan coating with 18 days storage at ambient temperature of 38^0C.

Table 5. Changes of external color of fresh and chitosan coated stored papaya

Treatments	Storage period, days											
	0 (fresh)			6			12			18		
	Color											
	L	C	H	L	C	H	L	C	H	L	C	H
T_1= Control				49.16	37.45	82.22	53.16	41.13	81.17	spoil	spoil	spoil
T_2= 1% chitosan sol^n				49.14	41.23	84.14	57.14	44.72	84.22	75.12	46.69	84.09
T_3= 2% chitosan sol^n	37.25	37.45	82.70	49.13	48.23	84.25	58.13	55.71	84.81	78.03	57.63	84.93
T_4= 3% chitosan sol^n				49.12	41.67	83.64	57.12	42.77	83.52	77.51	45.39	83.63
T_5= 4% chitosan sol^n				49.0	36.90	83.51	57.01	39.74	83.83	77.22	46.40	83.91

Papaya stored using 2% chitosan coating performed better considering the quality and external color even after 18 days of storage at ambient conditions.

Standardization of sweet potato powder for soup

Orange fleshed fresh sweet potatoes (*Ipomoea batatas*) were collected from Tuber Crops Research Centre in Bangladesh agricultural Research Institute, Joydebpur, Gazipur. Sweet potato roots were sorted out, weighed and washed, knife peeled and cut into 3 mm smaller pieces and immersed into potassium permanganate ($KMnSO_4$) solution for 10 min. Then, drain out the solution and blanching into water bath at 94^0C for 3 minutes. After blanching, cooling was done by tape water and water was removed by sieve. For drying, the sample was spread over the try and kept it into the oven dryer at 70^0C temperature for 48 hrs. After drying, milling the dried sample using high speed micro grinder (speed 25000 rpm). The powder samples were packed into high density polyethylene (HDPE).

Treatments

T_1 = without blanched sweet potato powder

T_2 = with blanched sweet potato powder

Results and Discussion

For the time being, investigation was done for the changes of physico-chemical quality parameters and external color of sweet potato as fresh and dried powder with and without blanched condition although the ultimate target was soup preparation. The dried sweet potato powder was stored in polyethylene packet at ambient condition for soup preparation as well as for long time preservation. The physico-chemical characteristics and external color of the fresh and dried powder were analyzed. For dried powder, one month interval analyzed data were taken for further investigation and it would be continued for six months. Only two months' powder data were analyzed and presented in the following section.

In Table 1 shows the changes of physico-chemical quality parameters and external color of sweet potato as fresh before dried in the year of 2015-2016. It was observed that the blanched sweet potato gave the less values both of physic-chemical quality parameters and external color as compared to the without blanched when the sweet potato analyzed as fresh before dried. It might be due to washing with water and blanching at high temperature for 3 minutes.

Table 1. Changes of physico-chemical quality parameters and external color of sweet potato as fresh before dried

Treatments	DM (%)	TSS (%)	p^H	Acidity (%)	Vitamin C (mg/100g)	β- carotene (μg/100g)	Color co-ordinates		
							L	a*	b*
Fresh (without blanched)	25.33	9.8	7.07	0.192	25.00	27.17	73.01	22.21	37.63
Blanched	15.82	6.7	7.33	0.098	14.43	19.64	34.30	12.63	10.13

In Tables 2 and 3 showed the changes starch, TSS, p^H, acidity, vitamin C and β- Carotene, reducing sugar and total sugar contents of sweet potato after dried as powder formation in the year of 2015-2016. It was found that the blanched sweet potato as well as longer storage period showed the less values of starch, TSS, p^H, acidity, vitamin C and β- Carotene, reducing sugar and total sugar contents of sweet potato as compared to the without blanched product when the sweet potato analyzed after dried as powder formation. It might be due to washing with water and blanching at high temperature for 3 minutes. Although the blanched product showed less value though it is suitable for consumption because of blanched product inactivate pathogenic microorganisms and bacteria.

Table 2. Changes of starch, TSS, p^H and acidity contents of sweet potato after dried as powder formation

Treatments	Starch		TSS (%)		p^H		Acidity (%)	
	Storage duration, months							
	1	2	1	2	1	2	1	2
T_1 = Without Blanched	15.53	15.01	5.3	4.5	6.19	6.48	0.64	0.51
T_2 = Blanched	18.12	17.95	5.5	5.2	5.98	6.30	0.74	0.59

Table 3. Changes of vitamin C (mg/100g) and β- Carotene (µg/100g), reducing sugar and total sugar contents of sweet potato after dried as powder formation

Treatments	Vitamin C (mg/100g)		β- carotene (µg/100g)		Reducing Sugar		Total sugar	
	Storage duration, months							
	1	2	1	2	1	2	1	2
T_1 = Without Blanched	18.30	16.29	39.07	29.39	26.31	19.08	29.04	21.55
T_2 = Blanched	14.63	10.49	26.58	27.61	22.72	17.99	24.76	21.18

Color is an important factor in the perception of sweet potato powder quality. The changes in the powder color were monitored by estimating lightness (L), chroma (C) and hue angle (H) with chromaticity a* and b* during storage at ambient condition. The values are presented in the Table 1 and 4 and it represented that the intensity of light yellow color of the without blanched fresh sweet potato were gradually increased with blanching with high temperature and turned light orange as evidence by increasing values of L with changing values of C and H accordingly.

Table 4. Changes of external color of sweet potato after dried as powder formation

Treatments	Color co-ordinates					
	Lightness (L)		a*		b*	
	Storage duration, months					
	1	2	1	2	1	2
T_1 = Without Blanched	19.12	15.41	5.12	2.16	13.78	11.41
T_2 = Blanched	8.78	11.24	8.11	3.13	19.12	15.24

Dried sweet potato powder was stored in polyethylene packet at ambient condition for longtime preservation. The experiments will be continuing this year for soup preparation with organoleptic test.

Effect of vapor heat treatment on the postharvest quality of tomato at ambient condition

The tomato fruits were collected from demonstration field of Horticultural Research Center, BARI. Three different maturity stages red, turning and matured green of BARI tomato 15 were investigated by applying vapor heat treatment at temperature 55^o C for the durations of 5 minutes. After applying Vapor heat treatment 10 fruits in each treatment were kept at ambient storage condition where average temperature was 33^o C and average relative humidity was 75%. Treatment combinations were Red stage + vapor treatment (RV), Turning stage + vapor treatment (TV), Mature green stage + Vapor treatment (MV) and non-treated Red stage (R), Turning stage (T), Mature green stage (M). For comparison and evaluations of treatment combinations different physiological, biochemical and biological parameters were investigated. The data were collected, analyzed statically and the mean differences among the treatments were compared by LSD.

Results and Discussion

Effect of vapor heat treatment on chemical properties of tomato

Total acidity and vitamin C content slightly affected by vapor heat treatment as compared to non-treated tomato at all stages red, turning and matured green . On the other hand, β- Carotene content and total soluble solid were not affected . Total acidity gradually increased up to 5 days after treatment and then sharply decreased with the storage time at all maturity stages of tomato. Vitamin C content gradually decreased in all cases during the storage time. TSS sharply increased at every stages of tomato with storage time and β- Carotene content sharply increased in case of non-treated tomato but slightly in treated tomatoes up to 5 DAT then rapidly increased with the storage times. Fallik *et al*, 1993 stated that heating did not affect tomato total soluble solid content and acidity by the end of 7 days' storage at 20^0C.

Weight loss (%)

Weight loss (%) more or less similar after 5 days of storages but increased and differed from each treatment within 10 days of storage then weight loss rapidly took place. In all stages of tomato more weight loss observed in treated tomato as compared to non-treated up to 10 days of storage then rapid loss occurred in case of non-treated tomato. Lowest weight loss observed in matured green and heighest in red stage (Table 1).

Shrinkage

Vapor heat effectively controlled shrinkage in all cases but very effective in matured green stage of tomato. Shrinkage took place rapidly and huge in red stage and less in matured green stage (Table 1).

Effects on decay / infection control

Vapor heat effectively controlled decay and postharvest pathogenic rot of the fruits by suppressing pathogenic activities, for that shelf life increased. Heat treatments have been reported to inhibit postharvest fungal germination and growth (Couey, 1989). The lowest decay and infected fruits was observed in matured green tomato and the highest was observed in non-treated full ripened tomato (Table 1).

Effects on marketability

Full and half ripened tomato showed too short shelf life and rapid reduction of marketability compared to matured green tomato. Vapor heat treatment clearly improved shelf life and marketability of tomato. The highest marketable fruits were observed at matured green stage and the lowest at non-treated in all stages (Table 2).

Table 1. Effect of vapor heat treatment on % weight loss, decayed and infection and shrinkage of tomato

Treatments	% weight loss			No. of decayed and infectted fruits			No. of Shrinked fruits		
	Days after treatment			Days after treatment			Days after treatment		
	5	10	14	5	10	14	5	10	14
R	4.21	12.95	29.32	5	2	2	3	3	3
RV	5.04	16.84	23.93	1	2	1	1	2	3
T	4.82	11.45	20.48	3	2	2	3	3	3
TV	4.36	12.03	20.33	0	1	1	1	2	3
M	3.52	8.56	23.30	2	2	2	1	2	3
MV	3.91	9.59	13.32	0	1	1	0	0	1
%CV	9.11	17.53	19.06	17.02	NS	17.15	17.24	18.49	19.78
LSD	0.7084	5.101	13.34	1.608	-	1.422	1.466	1.659	1.457

NB. Red stage + vapor treatment (RV), Turning stage + vapor treatment (TV), Mature green stage + Vapor treatment (MV) and non-treated Red stage (R), Turning stage (T), Mature green stage (M).

Table 2. Effects of vapor heat treatment on % marketability of tomato

Treatments	Days after treatment		
	5	10	14
R	100	70	40
RV	100	60	50
T	100	70	40
TV	100	85	70
M	100	75	45
MV	100	95	90

NB. Red stage + vapor treatment (RV), Turning stage + vapor treatment (TV), Mature green stage + Vapor treatment (MV) and non-treated Red stage (R), Turning stage (T), Mature green stage (M).

Pre-storage vapor heat treatment increase shelf life and reduces postharvest loss of tomato. Matured green stage of tomato and at 55^0C for 5 minutes' pre-storage vapor heat treatment is the suitable for ambient storage of tomato.

Effect of packaging technique on the quality and shelf life of bitter gourd

Fresh bitter gourd (*Momordica charantia* L) was collected from the producers' field. The bitter gourds were sorted out to remove the pest affected, over matured and damaged ones in the laboratory of Postharvest Technology Division. Then, the gourds were washed with 200 ppm chlorine water (Chlorax) and the excess water was removed by blower fan. Polypropylene of thickness 33 micron was used as packaging material and the packets were modified with different perforation (0%, 0.5%, 1.0% and 1.5% perforation) to restrict the respiration of the gourds. After packing, the bitter gourds were stored in ambient conditions and in air conditioned room at 24 ± 1^0C. The experiment was laid out in CRD factorial with 2 factors and three replications. The first factor was storage at ambient conditions and the second factor was storage at air conditioned room. Each replication of the treatments consisted of about one kilogram of bitter gourds. Temperature and humidity were recorded and close observations were made to record the physicochemical parameters like weight loss, firmness, rotting/decay, marketability, vitamin C and ß-carotene of the bitter gourd.

Package perforation (%)

The perforations on the packets were made by using a puncher machine. The number of perforations on each packet was determined using the following calculation-

Area of each packet = 45 cm x 36 cm = 1620 sq cm

Diameter of each hole (dia. of puncher rod) = 0.5 cm

From these data numbers of perforations were calculated to be 42, 83 and 124 for 0.5, 1.0 and 1.5% perforation, respectively.

Treatments

T_1 = Packet with zero perforation (sealed)

T_2 = Packet with 0.5% perforation

T_3 = Packet with 1.0% perforation

T_4 = Packet with 1.5% perforation

T_5 = Control (without packet)

E_1=Storage at embient conditions and E_2=Storage at air conditioned room at 24 ± 1^0C

Results and Discussions

Data on physicochemical parameters (weight loss, firmness, vitamin C and ß-carotene) and rotting/decay as well as marketability of the bitter gourds were analyzed at 2nd, 3rd, 4th and 5th days for both the ambient conditions and air conditioned storage. Ambient temperature was recorded during the experiment as 32^0 – 37^0C (max.) and 29^0 – 31^0C (min.). Again, ambient humidity was recorded as 72% - 88% (at 9:00am) and 82% - 92% (at 4:30 pm). Since the combined effect of packaging technique and storage conditions were significant in most of the cases, only the combined effects are described for interpretation as shown in the Tables 1 to 2.

The results showed that bitter gourd stored in packets maintained optimum weight loss, minimum rotting/decay and thus highest marketability as compared to that of control vegetables after 5 days of storage period .The bitter gourd packed in 1.5% perforated packets and stored at ambient conditions (E_1T_4) maintained optimum weight loss, minimum rotting/decay and thus highest marketability followed by the packet with the same perforation but stored in the air-conditioned room (E_2T_4) after 5 days of storage period .Conservation of excessive moisture content resulted more condensed water in the sealed polypropylene packets and lower perforated packets other than 1.5% perforation thus enhanced the rotting. On the other hand, bitter gourds kept in bulk without packaging (treatment E_2T_5) lost moisture drastically and shriveled rapidly as compared to E_1T_4 and E_1T_5. The storage of the bitter gourds in the polypropylene packets conserved the moisture hence prevented shrinkage and reduced the weight loss. Bitter gourds in the perforated packets lost moisture with respect to perforated openings but slower than the bulk and open storage. On the other hand, in air conditioned room the relative humidity was sufficiently low (50 to 55%) as compared to the ambient conditions to lose moisture content of the bitter gourd. Respiration involves the oxidative breakdown of complex substrate molecules, normally present in plant cells such as starch, sugars and organic acids to simpler molecules, in the course of which energy, carbon dioxide and water are given out. Yang *et al.* in 1984 used atmospheres low in O_2 (1–5%) and high in CO_2 (5–10%) to extend the shelf-life of fresh-cut fruits and vegetables by reducing respiration, product transpiration and ethylene production, as O2 is involved in the conversion of 1-amino-cycloprane-1-carboxylic acid to ethylene. In general, an inverse relationship has been shown between respiration rates of fruits and vegetables and their postharvest shelf-life.

Again, loss of firmness is one of the main factors limiting quality and the postharvest shelf-life of fruits and vegetables. The firmness in control bitter gourds decreased gradually along with increased storage time. Throughout storage, the loss of firmness of control was significantly greater than that of other treatment combinations. Packing the bitter gourds in the perforated polypropylenes delayed the decline of firmness. Reduced O_2 and high CO_2 levels have also been proved to effectively control enzymatic browning, firmness and decay of fresh-cut fruits and vegetables. Besides, the proliferation of aerobic spoilage microorganisms can be substantially delayed with reduced O_2 levels.

A substantial reduction was noted in ascorbic acid (vitamin C) contents of the bitter gourds during storage. The reduction could be due to both oxidative and non-oxidative changes as described by Eskin (1979) and Land (1962). Such changes altered the color of the bitter gourds and lowered the nutritive value. But, the β-carotene (vitamin A) content slightly increased during the storage period. The vegetables were harvested at immature and tender condition. So, during the storage periods the color and pigments increased and hence increased the ß-carotene content. Vitamin C was highest in treatment E_2T_4 followed by E_2T_3 over the storage periods (Table 1). Again, ß-carotene retention was highest in control vegetables followed by E_2T_3 over the storage periods (Table 2).

Table 1. Effect of packaging techniques on vitamin C (ascorbic acid) of bitter gourd during storage

Treatments	Storage periods, days				
	Initial	2days	3days	4days	5days
Vitamin-C, mg/100g during storage					
E_1T_1	128.18	114.11b	110.72bc	104.2a	78.40a
E_1T_2		113.63b	107.71c	104.05a	76.66a
E_1T_3		110.85bc	105.56c	99.19b	68.28b
E_1T_4		109.42c	105.19c	93.35c	53.98c
E_1T_5		88.22d	78.39d	72.28d	49.37c
E_2T_1		121.03a	117.20ab	104.02a	77.52a
E_2T_2		120.51a	120.59a	103.19a	78.08a
E_2T_3		119.02a	118.93ab	99.38b	79.48a
E_2T_4		118.28a	119.18ab	96.75bc	79.80a
E_2T_5		88.49d	80.49d	74.89d	52.52c
CV		1.66	4.80	2.23	4.52

Mean cores having the same letter suffix do not differ significantly at 5% (*) level of probability (DMRT)

Table 2. Effect of packaging techniques on vitamin A (β- carotene) of bitter gourd during storage

Treatments	Storage periods, days				
	Initial	2days	3days	4days	5days
β- carotene, μg/100g during storage					
E_1T_1	18.71	18.66e	18.75e	26.12d	28.62c
E_1T_2		18.92e	27.58c	27.37d	27.47c
E_1T_3		22.81cd	27.55c	30.58bc	31.29b
E_1T_4		26.18ab	31.73b	32.08b	31.28b
E_1T_5		27.89a	35.59a	36.00a	36.51a
E_2T_1		18.05e	17.71e	24.19e	28.62c
E_2T_2		18.21e	24.15d	26.70d	27.47c
E_2T_3		21.43d	25.54d	29.86c	31.29b
E_2T_4		24.57bc	28.33c	31.22bc	31.28b
E_2T_5		27.50a	34.64a	35.05a	36.51a
CV		5.65	4.14	3.27	2.05

Mean scores having the same letter suffix do not differ significantly at 5% (*) level of probability (DMRT)

E_1=Storage at ambient conditions, E_2=Storage at air conditioned room (24±1^{0}C), T_1 = Packet with zero perforation (sealed), T_2 = Packet with 0.5% perforation, T_3 = Packet with 1.0% perforation, T_4 = Packet with 1.5% perforation, T_5 = Control (without packet).

Bitter gourd packed in 1.5% perforated polypropylene and storing at ambient conditions is the best for quality and shelf life for 5 days considering its marketability and physiological changes. Again, the shelf life of the bitter gourds could not have extended beyond 5 days even in the air-conditioned rooms as relative humidity could not controlled there.

Effect of chlorination and wrapping technique on the quality and shelf-life of guava

Commercial matured guava 'BARI Peyara-2' was obtained from local grower's orchard and transported in plastic crates to the laboratory of PHTD, BARI. The fruits were then sorted for freedom from visual defects, uniformity of developmental stage, weight and size, and then randomly divided into six treatment groups. All the groups except control treatment were treated with 200 ppm chlorine (chlorax) water. Five groups of guava containing 5 fruits each were arranged as follows:

T_1 = Control (without chlorine wash and packet)

T_2 = Surface cling wraping

T_3 = Surface covered with tissue paper and then cling wraping

T_4 = Surface cling wraping and then covering with newspaper
T_5 = Surface covering only with newspaper

Results and Discussion

Temperature was recorded during the experiment as 29^0C – 31.6^0C at morning (around 9.00 am) and 33.8^0C – 35^0C at afternoon (around 5.00 pm) and it varied from 36.9^0C (maximum) to 28.6^0C (minimum). Again, relative humidity was recorded as 87% to 65% (at 9:00am) and 85% - 68% (at 4:30 pm).

Flesh firmness and surface colour

Flesh firmness is a critical quality attribute in relation to the consumer acceptability of fresh fruits and vegetables. The initial firmness of guava flesh that harvested after 6 months 18 days of flowering was 4.64 Newton (N), which gradually dicreased with storage time .Considerable differences in the fruit flesh firmness were noted among the treatments during storage time. However, the higiest fruit firmness was observed in the fruits that were preserved in the cling wraping (T_2) followed by the treatmentT_4, throughout 12 days of postharvest storage.

Surface colour changes of guava fruits were monitored by measuring cromaticity coordinates (L* and a*) during storage periods. Values are presented in Table 1. The intensity of green colour of fruit skin gradually decreased with extend the storage time and turned to lighter green as evidenced by increasing values of L* and changing values of a* accordingly (Table 1). The initial values of (L* and a*) were recorded as (57 and -9) in fruits during the first day of storage. Fruits under the treatments T_2 to T_5 exhibited a slower change in skin colour as indicated a more gradual increased in L* and changing values of a* accordingly after 12 days of storage as compared to the control treatment.

Total soluble solids (TSS), ascorbic acid and β carotene

Changes in TSS, ascorbic acid and β carotene content of guava fruits with post-harvest storage is presented in Table 2.

It is evident from Table 2 that the initial TSS of fruit samples was low (~8.4 %), which gradually increased with ripening. In control fruits, the TSS contents increased sharply and reached the maximum level of 9.1 % only after 12 days of storage, which was much higher than that found in fruits kept in different packages. Reduced O_2 and high CO_2 levels have also been proved to effectively control enzymatic browning, firmness and decay of fresh-cut fruits and vegetables. Besides, the proliferation of aerobic spoilage microorganisms can be substantially delayed with reduced O_2 levels.

It is also evident that the postharvest storage induced significant variation in ascorbic acid content of guava fruits during storage (Table 2). The ascorbic acid content was considerably decreased (82.31 mg 100 g^{-1}) in fruits that stored in ambient conditions without packaging after 12 days of storage. However, the maximum vitamin C retention was observed in treatment T_2 (107.89 mg/100gm) followed by the treatment T_4 (101.22 mg/100gm) and T_3 (98.69 mg/100gm), respectively at 12^{th} day of storage period (Table 2).

Total carotenoids content increased in stored guava and it increased faster in control fruit compared to treated fruits during storage. T_4 was most effective in slowing the total carotenoid formation in stored fruits (19.16 µg/g) even after 12 days of storage (Table-2). The efficacy of this treatment may be due to low activity of p*ectin methyl esterase* and delayed chlorophyll degradation in parallel with enzymatic action.

Weight loss and marketability

Guava fruit treated with 200 ppm chlorine water, transported in plastic crates and kept in cling wrapping have optimum weight loss and highest marketability (75%) after 12 days of storage. The transportation of the fruits in the crates protected these from the loading pressure and physical injury. Again, the storage of the guava in the packets conserved the moisture hence prevented shrinkage and reduced the weight loss. Guava fruits stored in the packets conserved moisture and respiration was controlled than the bulk and open storage. Again, low oxygen (O_2) and high carbon dioxide (CO_2) levels in the packets controlled enzymatic degreening and loss of firmness.

Table 1. Effect of chlorination and packaging techniques on the external color changes (L*, a* color space) of guava during storage

Effect of chlorination and packaging techniques on the external color changes of guava					
Treatments	Storage periods, days				
	Initial	3	6	9	12
Color co-ordinates (L*, a*)					
T_1	(57, -9)	(60, -5)	(63, -4)	(65, -3)	(68, -3)
T_2		(68, -7)	(66, -8)	(71, -5)	(72, -8)
T_3		(68, -9)	(69, -4)	(70, -8)	(71, -7)
T_4		(69, -6)	(70, -5)	(72, -6)	(73, -8)
T_5		(65, -7)	(67, -6)	(65, -7)	(64, -7)

T_1 = Control (without chlorine wash and packet), T_2 = Surface cling wraping, T_3 = Surface covered with tissue paper and then cling wraping, T_4 = Surface cling wraping and then covering with newspaper, T_5 = Surface covering only with newspaper

Table 2. Effect of chlorination and packaging techniques on the physico chemical parameters of guava

Treatments	Storage periods of guava, days				
	Initial	3	6	9	12
TSS (%)					
T_1	8.1	8.6a	8.6a	8.8a	9.1ab
T_2		8.6a	8.6a	8.7a	8.8b
T_3		8.5a	8.6a	8.7a	8.8b
T_4		8.6a	8.7a	8.8a	8.9b
T_5		8.5a	8.6a	8.6a	8.7b
CV (%)		1.77	2.46	2.80	2.45
Level of significance		*	*	*	*
Vitamin C (mg/100g)					
T_1	185.6	128.01c	107.89c	90.83e	82.31e
T_2		171.15a	132.64a	113.3a	107.89a
T_3		138.25b	130.10a	101.5bc	98.69bc
T_4		166.6a	131.69a	103.7b	101.22b
T_5		128.44c	113.12b	94.7de	90.66d
CV (%)		1.87	2.05	2.22	2.34
Level of significance		*	*	*	*
Total carotenoid (µg/g)					
T_1	13.8	15.23a	16.86a	19.15a	30.34a
T_2		14.87ab	15.85ab	17.84ab	19.91b
T_3		14.79ab	15.58b	17.45ab	19.55b
T_4		14.57b	15.14b	16.56b	19.28b
T_5		14.51b	15.12b	15.68b	19.16b
CV (%)		1.78	4.08	7.24	16.13
Level of significance		ns	ns	ns	ns

Mean scores having the same letter suffix do not differ significantly at 5% (*) level of probability (DMRT)

T_1 = Control (without chlorine wash and packet), T_2 = Surface cling wraping, T_3 = Surface covered with tissue paper and then cling wraping, T_4 = Surface cling wraping and then covering with newspaper, T_5 = Surface covering only with newspaper

Guava fruits pre-treated with chlorine water, transporting in plastic crates and then cling wrap packaging the best for quality and shelf life for 12 days of storage at ambient conditions considering its physical appearance, marketable quality and change of physico-chemical parameters. Beyond this storage period, rotting and decay of the fruits occurs rapidly, turn into faster softening and ripening, and hence lose marketable quality.

Determination of formaldehyde in selected fruits and vegetables

Some common fruits like mango (cv. Himsagar and Chosa), litchi (Bomby and China-3), jackfruit, latkan, blackberry, papaya and vegetables like carrot, okra, long yard bean, snake gourd, brinjal, tassel gourd, pumpkin, wax gourd were collected from local farmer. Onion (imported from India) was also collected from local market. All samples were analyzed for determining naturally produced formaldehyde. Mango and litchi varieties were analyzed both in ripe and over ripe stage. The analytical procedure was followed according the method described in AOAC (Method 931.08).

Results and Discussion

Estimation of formaldehyde in litchi

Two varieties of litchis ie. Bomby and China-3 were collected from farmer. After ripe and over ripe condition aril was collected and homogenized for formaldehyde extraction and detection. At ripe stage, highest level of formaldehyde was observed in cv. China-3 (2.35 ppm) followed by Bomby (1.256 ppm). At over ripe stage formaldehyde concentration was decreased in both Bomby and China-3 varieties (0.404ppm and 0.338ppm).

Estimation of formaldehyde in mango

One Bangladeshi mango variety Himsagar and other mango imported from India named Chosa were evaluated for estimation of naturally occurring formaldehyde. At ripe and over ripe stage of mango, pulp was collected and homogenized for formaldehyde estimation. It was observed that formaldehyde was detected both ripe and over ripe condition of fruits. At ripe stage formaldehyde was detected maximum in both varieties than its over ripe stage. Mango variety Himsagar produced maximum level of formaldehyde (5.493ppm) in ripe stage naturally than over ripe stage (94.085ppm). Formaldehyde was detected maximum in cv. Chosa also (5.124ppm) which was decreased at over ripe stage (3.943ppm) as like as cv. Himsagar.

Estimation of formaldehyde in other fruits

At ripe stage of jackfruit, latkan, blackberry and papaya naturally occurring formaldehyde was estimated. At ripe stage formaldehyde was detected in jackfruit 0.414ppm, latkan 5.458ppm, blackberry 1.893ppm and papaya 1.921ppm, respectively .

Estimation of formaldehyde in vegetables and onion

Naturally occurring formaldehyde was also estimated in some vegetables and onion. At mature stage of vegetables amount of formaldehyde was detected. It was observed that naturally occurring formaldehyde was produced 3.257ppm in okhra, 0.024ppm in long yard bean, 0.20ppm in snake gourd, 2.469ppm in pumpkin and 3.949ppm in wax gourd respectively. Naturally occurring formaldehyde was not detected in brinjal and tassel gourd . Onion which was imported from india showed maximum level of formaldehyde (17.069ppm) than local variety (2.837ppm) which was more or less same with the value cited in WHO publication (13.3-26.3ppm).

Fruits and vegetables naturally produce some amount of formaldehyde. More detail work will be continued for next year.

20 BIOTECHNOLOGY

Protocol Development and Micro propagation

Standardization of protocol for advanced lines of strawberry and their large scale multiplication.

The experiment was conducted with a view to develop a suitable protocol for rapid multiplication and hardening technique at nursery conditions. Strawberry lines (SB003, SB005) collected from fruits field of HRC, BARI were used as materials. Shoot tips of strawberry lines SB003 and SB005 were cultured on MS medium supplemented with combination of BAP, Kn and GA_3 along with a control. Shoot initiation was started within 6-7 days after culture. Five different treatments (T_0, T_1, T_2, T_3 and T_4) were used for shoot multiplication of explants. Percentages of explants producing shoots were best in T_4 treatment for both lines. In case of SB003 T_3 treatment and for SB005 T_2 and T_3 were best regarding shoot number, plant height and leaf number. ½ MS medium without hormone was used for root induction. Rooting performance was good in ½ MS medium for both lines. Small amount of plantlets were transferred in poly bags containing soil and cowdung and kept in the net house condition.

In vitro regeneration of okra (*Abelmoschus esculentus* L moench.)

The present research was undertaken to develop a simple and efficient regeneration protocol of okra aiming at future genetic transformation. Seedling-derived cotyledonary nodes and hypocotyl explants of BARI Dherosh-1 were cultured *in vitro* on MS medium supplemented with varying concentrations of 2,4-D, BAP, TDZ, BAP with NAA, BAP IAA and Zeatin with IAA along with a control. Shooting response (100%) with callus was only observed from cotyledonary nodes on TDZ where hypocotyls produced only callus or callus with roots on different concentrations of plant growth regulators. Considering the shooting response, the cotyledonary nodes of were cultured on various concentrations of TDZ for regeneration. The highest percentage (64.0) with maximum number (6.8) of shoots per explant were observed in 0.044 µM TDZ in 8.4 days. The regenerated shoots were rooted on ½ strength MS, MS supplemented with 2.46 µM IBA and 0.53 µM NAA. The highest percentage (83.3) and minimum days (9.7) required for root induction were recorded in 2.46 µM IBA. The rooted plantlets were transferred to soil and hardened in the plastic pots under green house conditions.

Rescue of Amritsagar banana from extinction through biotechnological approaches.

The experiment was undertaken with a view to collection and *in vitro* propagation of Amritsagar Banana variety and to prevent the extinction of the variety and reintroduce its cultivation at farmer's level. Amritsagar banana collected from Goforgoan and Kapasia were compared with each other by following the standard "Descriptor" for Banana (Musa spp.). This comparison demonstrates that Amritsagar banana collected from Goforgoan is more superior to that collected from Kapasia, in respect of fruit length, diameter, weight and total fruit number. Shoot tips of both the varieties were cultured on MS medium supplemented with different concentrations of BAP. Five treatments were tested for this study. Among the treatments, maximum no. of shoots was observed in T_3 treatment in both lines. Well developed shoots were transferred into ½ MS medium supplemented with different conc. of IBA for root induction. Five different treatments were (T_0, T_1, T_2, T_3 and T4) tested and maximum numbers of longest roots were observed in both lines in treatment T_3. The plantlets were transferred into the poly bags containing soil and cowdung mixture.

***In vitro* cormel production of Gladiolus.**

The experiment was carried out to develop an efficient cormel production protocol of gladiolus. To develop an efficient protocol for *in vitro* cormel production of BARI gladiolus-4, corm sections with buds and nodal segments of inflorescence at heading stage were used as explants which were cultured in MS medium with BAP (1,2,3,4 and 5) mg L^{-1} and NAA at (0.5 and 1.0) mgL^{-1}. When corm sections were used as explant, callus was initiated in the cultures after four to eight weeks. The maximum callus induction of 80% was observed on MS medium supplemented with BAP at 4 mg L^{-1} and NAA at 1 mg L^{-1}. The efficient shoot regeneration from proliferated calli was observed in the presence of BAP from 1 to 2 mg L^{-1} and also enhanced the earliest shoot induction (9.4 days). Shoot proliferation was maximum in MS medium supplemented with BAP 2 mg L^{-1} and NAA 1 mg L^{-1}. On the other hand, shoot initiation started in the nodal culture within two weeks (13.8 days) of inoculation. The highest number of shoots per explant (3.6) was obtained in MS medium supplemented with 4 mg L^{-1} BAP and 1 mg L^{-1} NAA. The longest shoot (8.5 cm) and leaves per shoot (3.6) was also found in the same treatment. The earliest rooting (11.6 days) and longest roots (5.3 cm) were observed in MS medium supplemented with IBA 2 mg L^{-1} and 5% sucrose.

Molecular Genetics and Genetic Engineering

PCR-based detection and characterisation of tomato leaf curl and other related Geminiviruses in Bangladesh.

The experiment was conducted with a view to characterise Geminivirus strains in different crops beginning with tomato. Phylogenetic analysis was carried out with sequence data of the complete ’A’ genome of 32 isolates that have been submitted to NCBI database and compared with related viruses from different parts of the world. Virus infected cucurbit leaf samples from five districts of Bangladesh were collected and DNA from the infected leaf samples along with the virus particles was isolated. Virus infected leaf samples of several other plants including okra, papaya, eggplant, yard long bean, bean, soybean, mungbean and blackgram have also been collected and DNA extracted for further analysis.

Transformation of tomato for broad-spectrum resistance against leaf curl viruses

The experiment was undertaken to construct of appropriate plasmid vectors for virus derived resistance against ToLCV and development of tomato plants with transformed virus sequences. Several experiments were conducted with a view to genetically transform tomato plants for broad-spectrum resistance against leaf curl viruses. Based on the genome sequence of various ToLCV strains, DNA fragments from three diverse ToLCV species were amplified and cloned. Two plasmid vectors were constructed for transformation work. Shoot regeneration has been observed from tomato explants following co-cultivation with *Agrobacterium* harbouring one of the binary vectors. Infectious clones of the most virulent leaf curl virus species were constructed and *Nicotiana benthamiana* indicator plants were agroinoculated resulting in the expression of leaf curl disease symptoms.

Marker-assisted transfer of salt tolerance *Nax* genes in Bangladeshi wheat varieties

The experiment was conducted with a view to develop salt tolerant wheat varieties using marker assisted selection. Two salt tolerant Austrailan wheat lines having Westonia background were crossed with two popular Bangladeshi wheat varieties BARI Gom-25 and BARI Gom-26. Plants carrying the salt tolerance genes were selected using molecular markers from BC_3 generation. Seeds (BC_3S_2) were harvested and kept for further analyses.

Assessment of stress-tolerance attributes in wheat using gene-specific molecular markers

Twenty-four wheat genotypes were characterized for the presence of three stress tolerance attributes by using gene specific molecular markers. Specific primer pairs for detecting wheat-rye translocation amplified PCR products of approximately 110 bp of 1RS rye chromosome fragment from 16 genotypes indicating presence of the translocation in these lines. In the second experiment, the same genotypes were screened for the presence of dwarfing genes where 19 genotypes showed the presence of either Rht-B1b or Rht-D1b allele having semi-dwarf phenotype. In the third experiment, a 16.9 kDa HSP gene was characterized by validating an SNP linked with thermo tolerance in wheat. Thirteen of the 24 genotypes, which failed to amplify the specific PCR product due to the presence of an SNP, were considered tolerant for heat stress.

Validation/on-farm trials

Observational trial of tissue cultured pineapple plantlets under field condition

The experiment was undertaken with a view to observe the performance of tissue cultured plantlets in respect of growth of plants, yield and quality of fruits. The experiment was conducted at ARS Pahartali, Chittagong during the period from September 2013 to June 2016. The Honey Queen cultivar was used as the tissue cultured materials against Natural plantlets. The tallest plant was observed in tissue cultured plantlets (80.93 cm) and the shortest plant was observed in natural sucker (73.50 cm). The tallest and widest fruit was achieved from natural sucker (9.92 and 8.20 cm respectively) and the shortest and narrowest was achieved from tissue cultured plantlets (8.31 and 7.75 cm respectively).The highest TSS was obtained from tissue cultured plantlets (16.12 %) and the lowest TSS was obtained from natural sucker (14.23 %).

ABSP-II research activities

Breeder seed production of Bt brinjal varieties

The experiment was carried out with a view to produce the good quality seed of Bt brinjal varieties at different locations. Breeder seed production programme of BARI Bt begun-1, BARI Bt begun-2, BARI Bt begun-3 and BARI Bt begun-4 was conducted at 13 locations of the country under the supervision of Biotechnology Division of BARI during the winter season of 2015-16. Total amount of seed harvested as 228, 189.5, 104 and 370 kg from BARI Bt begun-1, BARI Bt begun-2, BARI Bt begun-3 and BARI Bt begun-4, respectively. Among them amount of breeder seed was 661 kg against the target of 500 kg.

Confined field trial of Bt brinjal lines

The experiment was conducted with to achieve homozygosity for the rest two Bt brinjal lines. Confined field trials of five Bt Brinjal lines were conducted at the confined field of Biotechnology Research field, BARI Gazipur during 2015-16. Bt Dohazari, Bt Shingnath and Bt Khatkhatia were proposed to release as BARI Bt begun-5, BARI Bt begun-6 and BARI Bt begun-7 respectively. Bt Islampuri and Bt Chega are under observation to propose as new variety.

Maintenance of Bt brinjal varieties

The lines were undertaken with a view to produce the nucleus seed of Bt brinjal varieties. A trial of was conducted for maintenance of five Bt Brinjal lines and three Bt brinjal varieties at the confined field of Biotechnology Research field, BARI Gazipur during 2015-16. Amount of seed as 1165g, 150 g, 70 g, 84 g, 220 g, 100 g, 178 g and 112 g were harvested from Bt Dohazari, Bt Khatkhatia, Bt Singnath, Bt Chega, Bt Islampuri, BARI Bt begun -1, BARI Bt begun -3 and BARI Bt begun -4, respectively.

Production of breeder's propagule of transgenic late blight resistant potato clones through tissue culture

The experiment was carried out with a view to produce plantlets/minitubers of selected LBR potato clones. Transgenic SP 951(137) was used as parent materials. Sprouts of this clone were used as explant. Sprouts were cultured on PROP medium and multiplied in vitro. Initially 30 tubers were used as source of explants after in vitro multiplication this materials were go through ELISA test to detect the virus free explants source and 10 explants plant source were free from virus. Subsequent subculture was done only for virus free materials to produce the virus free plantlet. This virus free plant let will be maintained *in vitro* as well as it will be grown under green house condition to produce mini tubers as breeder's propagule.

21 SOIL MANAGEMENT

Development of Fertilizer Recommendation for four Crop based cropping pattern: Mustard-Mungbean-T.Aus-T.Aman

A field experiment on Mustard-Mungbean-T.Aus-T.aman cropping pattern was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur during the year of 2013-2014 to 2015-2016 with the objective of finding out suitable fertilizer combination for sustainable yield of the pattern, monitor soil health as affected by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight different treatments viz. T_1: 100% NPKSZnB (STB), T_2: T_1 + 25% N, T_3: T_1 + 25% NP, T_4: T_1 + 25% NK, T_5: T_1 + 25% PK, T_6: T_1 + 25% NPK, T_7: 75% of T_1, T_8: Native fertility. The experiment was laid out in RCBD design with three replications. Data revealed that the mustard (BARI Sarisha-14) seed yield was statistically influenced by the fertilize treatments. The highest seed yield of 1.79 t ha^{-1} was obtained from the T_6 treatment where 25% additional NPK was added over the 100 % STB rate in 2013-14. This yield was statistically similar with that produced by all the other fertilizer treatments except the native fertility treatment. In 2014-15, the yield data was affected seriously due to low plant stand. The legume component mungbean (BARI Mung 6) produced up to 1.38 t ha^{-1} grain yield but the grain yield showed no treatment effect statistically. The green biomass incorporated into the soil ranged from 11.33 t ha^{-1} to 15.67 t ha^{-1}. The T. Aus and T. Aman rice yield was influenced statistically but there was no treatment effect on the grain yields. The treatment T_6, however, showed the highest yield for all the components. The highest total rice (system) yield of 14.44 t ha^{-1} $year^{-1}$ was obtained from T_6 treatment where 25% NPK was added with 100% STB rates.

Nutrient uptake by the Maize-Mungbean-T. aman cropping pattern

Nitrogen uptake by maize crop in the year 2012-13 ranged from 58.8 kg in the control treatment to 232.28 kg ha^{-1} in the T_5 treatment where poultry manure was applied with the HYG chemical fertilizers (Table 9a). The other nutrients uptake were also the highest in thei treatment (T_5). This is mainly because of the higher yield was obtained from this treatment.

Nitrogen uptake by rice crop in the year 2012 ranged between 106.7 kg ha^{-1} in the control treatment to 154.9 kg ha^{-1} in the T_2 treatment where CD was added with the MYG chemical fertilizers (Table 9b). The highest P uptake by rice was noticed from the T_3 treatment, highest K uptake was with the treatment T_3 and highest S uptake of 31.9 kg ha^{-1} was in the T_2 treatment.

The nitrogen removal by mungbean grain ranged from 20.1 kg ha^{-1} to 43 kg ha^{-1} (Table 7c). The range of P removal was 10.37-4.66, k ranged from 12.7 to 6.00 and S ranged from 4.42 to 2.05 kg ha^{-1}. The nutrient recycled by mungbean green biomass was estimated as nitrogen 16.1 to 60.3, P 12.50 to 43.9, K 16.05 to 60.33 and S 18.15 to 76.75 kg ha^{-1}.

Apparent nutrient balance of major nutrients calculated after three cropping cycles, indicated that the balance for some nutrients are negative. Against the added N of 132-157 kg N ha^{-1} $year^{-1}$ the removal ranged between 113 and 301 kg N ha^{-1} leaving a negative balance of 90 to 144 kg N ha^{-1}. Likewise varying levels of negative balance was observed with K, and S. Except the native fertility treatment positive balance of P was noticed.

Determination of optimum sowing date of wheat in grey terrace soil of gazipur (aez-28) using apsim model

Wheat (*Triticum aestivum* L.) is one of the most important crops in the world, and models have been widely used to study yield responses of wheat to changes in management and climate. However, less information is available on how a model performs in simulation of wheat response to changes in sowing dates across space. This study presented an evaluation of the APSIM (Agricultural Production Systems Simulator)-Wheat model using data from field experiments consisting of fourteen sowing dates. Wheat variety BARI Gom-26 was sown in a randomized complete block design (RCBD) at Grey Terrace Soil of Gazipur (24.00º N latitude and 90.05º E longitude; 8.4 m elevation) (AEZ-28) during 2015-2016. The APSIM-Wheat model was calibrated and validated and then used to determine the optimum sowing dates with 14 sowing dates from 1 November, 2015 to 5 January, 2016 with 5 days interval using long-term historical weather data (1990-2016) from the Gazipur location. The results showed that the APSIM-Wheat model could capture a large part of the variation in phenology, biomass and yield for the same variety in the study area. However, errors of simulation in phenology and yield were increased with delay in sowing date. Long Term scenarios showed that the best period of sowing BARI Gom 26 wheat variety during rabi season in Grey Terrace Soil of Gazipur (AEZ-28) ranged from 11 November to 1 December.

Characterization and utilization of crop residue/agro-industrial waste generated from different crops/agro-industries in bangladesh

A study was conducted during the year of 2015-16 to find out the characterization and utilization of different crop residues/agro-industrial wastes. Crop residues are collected from rice, wheat, maize, ground nut, soybean, and sugarcane and coconut field. Agro-industrial wastes were collected from rice mill, wheat and maize flour mill, sugar mill, rice bran oil and coconut oil mill. Collected crop residue/wastes are analyzed for moisture, ash content, volatile matter content, fixed carbon content, bulk density, calorific value, carbon and nitrogen content. Crop residues/agro-industrial wastes under study were characterized by high moisture and high volatile matter content, low ash and low fixed carbon content, low bulk density, irregular shape and low energy content. Present use of crop residues/agro-industrial wastes were livestock feed, fish feed, fuel, mulching materials, soil conditioner, bedding material for animal etc. These wastes can be used for particle board, hard board, show piece for decoration and other household appliances, compost, bio gas, gasification, incineration etc.

Development of fertilizer recommendation for maize With broccoli intercropping system

An experiment was conducted at BARI Central Research Station, Gazipur and On Farm Research Division, BARI, Rangpur during the rabi season of 2015-16. The experiment was set up with seven treatments viz. T_1 (100% RDCF of Maize + 0% RDCF of Broccoli), T_2 (100% RDCF of Maize + 5% RDCF of Broccoli), T_3 (100% RDCF of Maize + 10% RDCF of Broccoli), T_4 (100% RDCF of Maize + 15% RDCF of Broccoli), T_5 (100% RDCF of Maize + 20% RDCF of Broccoli), T_6 (100% RDCF of Maize + 25% RDCF of Broccoli) and T_7 (100% RDCF of Maize + 30% RDCF of Broccoli). Highest yield of maize (7.94 & 9.83 t ha^{-1} at Gazipur & Rangpur, respectively) and highest yield of broccoli (28.2 & 24.5 t ha^{-1} at Gazipur & Rangpur, respectively) was recorded in T_7 treatment (100% RDCF of Maize + 30% RDCF of Broccoli). Highest gross margin of 314460 Tk. ha^{-1} and highest BCR of 3.81 was obtained from T_7 treatment.

Use of vermicompost for improving cabbage yield and soil health

An experiment was conducted at BARI Central Research Station, Gazipur, Regional Agricultural Research Station, Jessore and On Farm Research Division, BARI, Rangpur during the *rabi* season of 2015-16. The experiment was set up with seven treatments viz. T_1 =100% recommended dose of chemical fertilizer (RDCF), T_2 = 80% RDCF, T_3 = 60% RDCF, T_4 = 100% RDCF + vermicompost (VC) @ 1.5 t ha^{-1}, T_5 = 80% RDCF + VC @ 3 t ha^{-1}, T_6 = 60% RDCF + VC @ 6 t ha^{-1} and T_7 = absolute control. Highest yield (68.0, 58.4 & 60.8 t ha^{-1} at Gazipur, Rangpur and Jessore, respectively) was recorded in T_4 treatment (100% RDCF + vermicompost @ 1.5 t ha^{-1}). Soil health was improved substantially with the application of vermicompost. Highest gross margin of 219010 Tk. ha^{-1} and highest BCR of 2.36 was obtained from T_4 treatment.

Liming effect of poultry litter biochar in acidic soil

The effectiveness of poultry litter and poultry litter biochar to ameliorate the soil acidity of an acid soil was investigated through incubation and pot experiments using lime as comparison. The soil was amended with liming materials viz. lime (1 g kg^{-1}), poultry litter (5, 10 and 15 g kg^{-1}) and poultry litter biochar (5, 10 and 15 g kg^{-1}) were used to observe their effect. A pot experiment was also conducted using similar treatments to observe the responses of maize crop to application of amendments. All liming materials increased soil pH and decreased soil exchangeable acidity. Application of high rate of poultry litter biochar achieved greater increase in soil pH and reduction in soil exchangeable acidity. All amendments increased one or more soil exchangeable base cations. Lime only increased soil available calcium, while poultry litter (PL) and poultry litter biochars (PLB) increased soil available Ca, Mg and K and also soil available P. Application of the amendments enhanced the uptake of one or more nutrients of N, P, K, Ca and Mg by maize in pot experiments. When PL and PLB amendments were compared, it was found that the PLB the best choice for amelioration of acid soil. The PLB achieved a greater amelioration effect on soil acidity and increased soil nutrients of Ca, Mg and K, but also enhanced the uptake of Ca, Mg, K and P by plants simultaneously.

Effect of vermicompost on tomato yield and soil health

An experiment was conducted at BARI Central Research Station, Gazipur, during the *rabi* season of 2015-16. The experiment was set up with seven treatments viz. T_1=100% recommended dose of chemical fertilizer (RDCF), T_2=80% RDCF, T_3=60% RDCF, T_4=100% RDCF + vermicompost (VC) @ 1.5 t ha^{-1}, T_5= 80% RDCF + VC @ 3 t ha^{-1}, T_6= 60% RDCF + VC @ 6 t ha^{-1} and T_7= absolute control. Highest yield (75.4 t ha^{-1}) was recorded in T_4 treatment (100% RDCF + vermicompost (VC) @ 1.5 t ha^{-1}). Soil health was improved substantially with the application of vermicompost.

Effect of IPNS on the yield and nutrient uptake of crops of cauliflower-amaranth-t. Aman cropping pattern

A field experiment on Cauliflower-Amaranth-T. aman cropping pattern was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur and Tista Meander Floodplain Soil (AEZ-3) at OFRD, Bogra during the year of 2014-2015 and 2015-16 with the objectives to maintain or enhance soil productivity through a balanced use of mineral fertilizers combined with organic sources of plant nutrients, improve the efficiency of plant nutrients thus limiting losses to the environment and to increase sustainable crop yield. There were eight treatments viz. T_1: Native nutrient, T_2: 100% STB, T_3: 75% STB + 3 t ha^{-1} PM, T_4: IPNS + 3 t ha^{-1} PM, T_5: 75% STB + 5 t ha^{-1} CD, T_6: IPNS + 5 t ha^{-1} CD, T_7: 75% STB and T_8: 125% STB. IPNS means releasing amount of nutrient of cowdung and poultry manure were subtracted from STB chemical fertilizers. The experiment was laid out in RCB design with three replications. Data revealed that the T_4 treatment produced the highest yield of cauliflower 48.10 t ha^{-1} in 2014-15 and 52.70 t ha^{-1} in 2015-16 at Gazipur and 43.0 t ha^{-1} in 2014-15 and 49.12 t ha^{-1} in 2015-16 at OFRD, Bogra. This trend of influence was consistent for almost all the yield contributing characters of cauliflower in both the location. The highest yield (63.33 t ha^{-1}) of amaranth was noted in T_4 (IPNS + PM) treatment. The highest yield of T aman 4.27 t ha^{-1} at Gazipur and 5.46 t ha^{-1} at OFRD, Bogra in 2014-15 were found in T_4 (IPNS + PM) treatment. The native nutrient treatment produced the lowest yield in case of all crops.

Effect of ipns on for sustaining soil fertility and yield of maize-mungbean-t. Aman rice cropping pattern

The experiments were conducted at BARI, Gazipur and OFRD, Bogra during *rabi* season of 2014-15 and 2015-16 with the objectives to maintain soil productivity through a balanced use of mineral fertilizers combined with organic sources of plant nutrients, improve the efficiency of plant nutrients, thus limiting losses to the environment, increase sustainable crop yield and to increase farmer's income. There were eight treatments viz. T_1: Native fertility, T_2: 100% STB, T_3: 75% STB + 5 t ha^{-1} CD, T_4: IPNS + 5 t ha^{-1} CD, T_5: 75% STB + 3 t ha^{-1} PM, T_6: IPNS + 3 t ha^{-1} PM, T_7: 125% STB and T_8: 75% STB. IPNS means releasing amount of nutrients of cowdung and poultry manure were subtracted from STB chemical fertilizers. The experiment was laid out in RCB design with three replications. Data revealed that the T_6 treatment produced the highest grain yield of maize 8.46 t ha^{-1} at Gazipur and 10.67 t ha^{-1}at OFRD, Bogra in 2014-15. In the year of 2015-16, the highest grain yield of maize 8.73 t ha^{-1} at Gazipur and 8.11t ha^{-1} at OFRD, Bogra was noted in T_6 treatment. The highest grain yield of T. aman 3.82 t ha^{-1} at Gazipur and 3.81 t ha^{-1} at OFRD, Bogra was observed in T_6 treatments. The highest grain yield of maize and T. aman was statistically almost similar to all integrated nutrient treatments in both the location. This trend of influence of the treatments were observed with most of the yield contributing characters of maize and T. aman rice crop.

Integrated nutrient management for sustainable production and quality of onion

The experiment was conducted at BARI, Gazipur during *rabi* season of 2014-15 and 2015-16 with the objectives to find out the economic value of responses of onion to INM based treatments, enhance soil fertility, increase yield and to assess the nutrient uptake determining net changes in the soil nutrient balance. There were nine treatments viz. T_1: Native fertility, T_2: 100% STB, T_3: 125% STB, T_4: 100% STB + 5 t ha^{-1} CD, T_5: 100% + 3 t ha^{-1} PM, T_6: 100% STB + 5 t ha^{-1} VC, T_7: 75% STB + 5 t ha^{-1} CD, T_8: 75% + 3 t ha^{-1} PM, T_9: 75% STB + 5 t ha^{-1} VC. The experiment was laid out in RCB design with three replications. The highest yield of onion 21.69 t ha^{-1} in 2015 was obtained from T_4 treatment (100% STB chemical fertilizers + 5 t CD ha^{-1}) and 14.13 t ha^{-1} in 2016 was observed from T_6 treatment (100% STB chemical fertilizers + 5 t VC ha^{-1}) which was statistically similar to all integrated nutrient treatments except T_9 in 2015 and T_7 in 2016 and control treatments. The lowest yield of onion 13.70 t ha^{-1} in 2015 and 9.85 t ha^{-1} in 2016 was noted in control treatment.

Effect of integrated nutrient management on the yield and quality of sweet pepper

The experiment was carried out at On-farm Research Division, Rangpur to investigate the effect of integrated nutrient management on the yield and quality of sweet pepper. There were six treatments: T_1 = 100% RD ($N_{115}P_{70}K_{125}S_{20}Zn_2$ kg ha^{-1}), T_2 = 75% RD + 5 t ha^{-1} CD, T_3 = 75% RD + 5 t ha^{-1} CD Slurry, T_4 = 75%RD + 3 t ha^{-1} PM, T_5 = 75%RD + 3 t ha^{-1} PM Slurry, T_6 = Native fertility. The tested variety was BARI Misti Morich-1. The experiment was laid out in randomized complete block design (RCBD) with 3 replications. Results revealed that the T_5 (75% RD+ 3 t ha^{-1} PM Slurry) produced the highest fruit yield (25.79 t ha^{-1}) and the lowest yield (11.27 t ha^{-1}) was in control treatment (native fertility). An inclusion of 3 t PM Slurry ha^{-1} with 75% RD can reduce 25% of chemical fertilizer. Integrated use of PM Slurry at the rate of 3 t ha^{-1} with 75% RD was found as the best combinations in respect of sweet pepper yield and probable of enriching the soil organic matter.

Development of fertilizer recommendation for four crop based cropping pattern: Mustard-Boro-T.Aus-T.Aman

A field experiment on Mustard – Boro-T. Aus-T. Aman cropping pattern was conducted in the soil (AEZ 8 and 11) of Jamalpur and Jessore during the year of 2014-2015 to find out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as affected by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight different treatments viz. T_1: 100% NPKSZnB (STB), T_2: T_1 + 25% N, T_3: T_1 + 25% NP, T_4: T_1 + 25% NK, T_5:T_1 + 25% PK, T_6:T_1 + 25% NPK, T_7: 75% of T_1,T_8: Native fertility. The experiment was laid out in RCB design with three replications. Data revealed that the yield of mustard (BARI Sarisha-14) grain yield was statistically influenced by the fertilizer treatments. The highest grain yield of 1.86 t ha^{-1} at Jamalpur and 1.73 t ha^{-1} at Jessore were obtained from the T_6 treatment where 25% additional NPK was added over the 100 % STB rate in 2014-15. This yield was statistically similar with that produced by all the other fertilizer treatments except the native fertility treatment. Boro, T. Aus and T. Aman rice yield was influenced statistically. The treatment T_6, however, showed the highest yield for all the components.

Development of fertilizer recommendation for four crop based cropping pattern: Potato-Boro-T.Aus-T.Aman

A field experiment on Potato-Boro-T. Aus-T.aman cropping pattern was conducted in the High Ganges Floodplain Soil of Jessore (AEZ 11) during the year of 2014-15 to find out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as affected by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight different treatments viz. T_1: 100% NPKSZnB (STB), T_2: T_1 + 25% N, T_3: T_1 + 25% NP, T_4: T_1 + 25% NK, T_5: T_1 + 25% PK, T_6: T_1 + 25% NPK, T_7: 75% of T_1, T_8: Native fertility. The experiment was laid out in RCB design with three replications. Data revealed that the tuber yield of potato (Diamant) was statistically influenced by the fertilizer treatments. The highest tuber yield of 25.70 t ha^{-1} was obtained from the T_6 treatment where 25% additional NPK was added over the 100% STB rate in 2014-15. This yield was statistically similar with that produced by all the other fertilizer treatments except the native fertility treatment. Yield of Boro, T. Aus and T. Aman rice yield was influenced statistically. The treatment T_6, however, showed the highest yield for all the components.

Effect of biochar and bioslurry on soil moisture conservation and yield of wheat

The experiment was carried out at Regional Agricultural Research Station (RARS), Jamalpur, during November, 2015-2016 to observe the comparative performance of integrated plant nutrient system (IPNS) and moisture conservation through the use of organic manure (cowdung, biochar and bioslurry) and inorganic fertilizer on wheat. There were five treatments viz. T_0 : control, T_1 : Chemical fertilizer (STB), T_2 : Chemical fertilizer + cowdung @ 5 t ha^{-1} IPNS basis, T_3 : Chemical fertilizer + biochar @ 5 t ha^{-1} IPNS basis, T_4 : Chemical fertilizer + bioslurry @ 5 t ha^{-1} IPNS basis. Among the treatments, the highest grain yield (4.81 t ha^{-1}) was obtained from bio-slurry treated plot (T_4 treatment) which was statistically identical to T_2 and the lowest (3.70 t ha^{-1}) from T_0 (control) treatment.. The maximum amount of soil moisture percent was found in treatment T_4 i.e. bio-slurry treated plot and treatment T_0 i.e. control treatment contains comparatively lower percent of soil moisture. As T_4 treatment contain maximum moisture it creates favourable environment and sustained action of bioslurry to influence growth characteristics and yield of wheat.

Nutrient management for sustaining soil Fertility and performance of Wheat-Mungbean-T.Aman cropping pattern

A field experiment on Wheat-Mungbean-T.aman cropping pattern was carried out in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishurdi, Pabnaduring the period of 2000-2016. There were six treatments viz. 125% of recommended dose (RD =120-35-75-20-5 kg of N P K S Zn ha^{-1}), 100% of RD, 75% of RD, 50% of RD, farmer's practice and native fertility replicated three times. The highest yield were obtained in the 125% of RD treatment those were similar to the 100% RD treatment. The results revealed that soil fertility sustained in 125% of RD and 100% of RD.

Nutrient management for sustaining soil fertility and performance of Mustard-Mungbean-T.Aman cropping Pattern

A field trial was carried out at Regional Agricultural Research Station, Ishurdi, Pabna during the period of 2000-2016 in High Ganges River Floodplain Soils (AEZ-11) of Ishurdi to find out sustainable fertilizer doses for Mustard-Mungbean-T.aman cropping pattern, to monitor soil health and productivity of the cropping pattern. There were three levels each of N (80, 120 and 160 kg ha^{-1}), P (18, 36 and 54 kg ha^{-1}) and K (35, 70 and 105 kg ha^{-1}) in the treatment combinations. The combined effect of 120-36-70-40-3-1 kg ha^{-1} of NPKSZnB (T_2) produced the highest grain yield (1.47 t ha^{-1}) of Mustard, grain yield (1.43 t ha^{-1}) of Mungbean and grain yield of T. aman (5.47 t ha^{-1}).

Effect of different planting methods on soil salinity and yield of tomato in saline areas

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the *rabi* season of 2015-16 to examine the change of soil salinity and yield of field-grown tomato under different planting methods. There were four treatment combinations viz. T_1= Saline water (>6dS m^{-1}) + Conventional planting method i.e. control, T_2 = Saline water (>6dS m^{-1}) + Flat bed planting method, T_3 = Saline water (>6dS m^{-1}) + Furrow bed planting method and T_4= Saline water (>6dS m^{-1}) + Slope (tan 45^0) bed planting method. The highest fruits yield (70.64 t ha^{-1}) was recorded in T_4 treatment. The lowest fruit yield (64.89 t ha^{-1}) was recorded in T_1 treatment. Highest BCR of 1.93 was obtained from T_4 treatment. Highest reduction of soil salinity was recorded (15.07%) in T_4 than the control treatment. Irrigation water requirement was reduced 13.96% in T_4 than the control treatment.

Effect of different sources of irrigation water on nutrient content and uptake in maize in saline region of satkhira

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the *rabi* season of 2015-16 to know the effect of different sources of irrigation water on nutrient content and uptake in maize. There were 4 treatments viz. T_1 = Surface water, T_2 = Underground water, T_3 = River water and T_4 = Underground water and river water (1:1). The highest grain yield was (11.32 t ha^{-1}) recorded in T_2 and lowest was (8.32 t ha^{-1}) in T_3. Highest level of MBCR (3.62) was recorded in T_4. Soil and water salinity range of T_1, T_2, T_3 and T_4 were 3.36-10.11 and 2.01-6.19, 3.03-8.11 and 1.95-6.00, 3.05-12.35 and 3.51-14.18, 3.91-9.55 dS m^{-1}, respectively.

Effect of nitrogen and foliar application of boron on yield and quality of mustard

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the *rabi* season of 2015-2016 to know the effect of different levels of nitrogen and foliar application of boron on mustard. There were three nitrogen levels (N_1 = 90 kg N ha^{-1}, N_2 = 120 kg N ha^{-1} & N_3= 150 kg N ha^{-1}) and three stages of foliar application of boron (B_1 = Foliar application of Boron in pre-flowering stage, B_2 = Foliar application of Boron in flowering stage & B_3 = Foliar application of Boron in grain filling stage). Foliar dose of Boron was 400 g $liter^{-1}$. The highest seed yield was (1.52 t ha^{-1}) recorded in N_3B_1 and lowest seed yield was (1.12 t ha^{-1}) was in N_1B_3. N_3B_3 gave the highest MBCR (5.84). The lowest level of soil salinity was recorded in sowing time (3.18 ds m^{-1}) in N_1B_2 and the highest level of salinity (10.56 ds m^{-1}) was recorded in N_2B_2 at the harvesting stage.

Determination of crop coefficient values of wheat and leaching loss of nutrients by drainage lysimeter

A study on wheat (cv. BARI Gom -26) was conducted in the drainage Lysimeter located in the Central Research Farm, BARI, Gazipur during rabi 2015-2016. The objectives of the study were to find out the location specific crop coefficient (Kc) values of wheat and to determine leaching loss of nutrients. Four regimes of irrigation water was applied on the basis of depletion over field capacity (FC) at pre determined intervals such as T_1: Irrigation up to FC at 15 days interval, T_2: Irrigation up to FC at 25 days interval, T_3: Irrigation up to FC at 35 days interval and T_4: Irrigation up to FC at 45 days interval. As such, 6, 4, 3 and 2 irrigations were needed for T_1, T_2, T_3 and T_4, respectively. The experiment was conducted in completely randomized design with 3 replications. The highest yield (4.57 t ha^{-1}) was obtained from T_2, which was statistically identical to T_1 and T_3 but significantly higher over T_4. Therefore, Kc values were calculated from the best performed treatment, T_2. The estimated Kc values of wheat found to be 0.36, 0.91, 1.10 and 0.12 for initial, crop development, mid season and late season stages, respectively. Such Kc values appeared to be slightly lower than the FAO recommended one. But FAO data are generalized for a certain region of the world whereas our estimated values are location specific. Therefore, Kc values found in this experiment could be used under Bangladesh context for the estimation of water requirement of wheat. Considerable amount of plant nutrients (P, K, Ca, Mg, S, Zn and B) was lost through leaching. This should be taken into account for ensuring crop nutrition and minimizing ground water pollution.

Effects of tillage methods and residue managementOn soil properties and yield of Potato- Maize-T. Aman Rice cropping pattern

Field experiments on Potato- Maize-T.aman rice cropping pattern were conducted in Grey Terrace Soil of Gazipur under AEZ-28 and Dark Grey Floodplain Soil of Jamalpur under AEZ-9. The experiment started in 2013-2014 and running its third cycle in this year (2015-16). The objectives of the study were to observe the effect of tillage practices and residue management on soil properties and to increase the productivity of the said cropping sequence. Three tillage methods such as minimum tillage (4-6 cm depth) with power tiller operated seeder (PTOS), conventional tillage (10-12 cm depth) with power tiller and deep tillage (20-25 cm depth) by chisel were employed. Besides, three types of residue management options viz. farmers practice (without residue), 50% crop residue incorporation and 100% crop residue incorporation for potato and 15 cm and 30 cm stubbles of maize and rice were incorporated to soil for the subsequent crops. The study was conducted in a factorial randomized complete block design with three replications. Deep tillage gave significantly higher yield over minimum tillage for all three crops of the pattern except T. aman rice at Jamalpur. Residue incorporation also brought yield benefit to a considerable extent in both the locations. For interaction, T_3 x M_3 combinations resulted in higher yield for all the tested crops under this pattern. The said treatment also showed the highest potato equivalent yield (PEY) for both the locations. The PEY varied from 32.49 to 43.21 t ha^{-1} at Gazipur while such variation was 37.95 to 50.17 t ha^{-1} at Jamalpur where the highest contribution was observed from T_3 x M_3 followed by T_3 x M_2 and the lowest in T_1 x M_1. Minimum tillage irrespective of residue incorporation showed the yield loss over conventional practice (T_2 x M_1) although such reduction was lower in residue treated plots. Residue incorporation in combination with deep tillage brought about 16.7% and 15.6% yield benefit over conventional practice for Gazipur and Jamalpur, respectively. The third cycle of the pattern is continuing with seventh crop maize is in grain filling stage till the preparation of the present report.

Effect of raised bed planting and potassium application on the mitigation of soil salinity and yield of maize

A field experiment on hybrid maize (cv. BARI maize-9) was conducted in coastal saline soil at Hazirhatt, Noakhali under Young Meghna Estuarine Floodplain (AEZ-18) and also at Kuakata, Patuakhali under Ganges Tidal Floodplain (AEZ-13) during late rabi 2014-2015 and 2015-2016. The objectives were to test the possibility that salinity damage can be reduced by elevating K fertilization rate and to study the effects of planting method and K fertilization interactions on maize yield and nutrient uptake under salt stress condition. Four rates of fertilizer K (Native K, 100% STB K, 125% STB K and 150% STB K) were tested combining with two planting methods (Flat land and Raised bed) in a factorial randomized complete block design with three replications. Other nutrients were also applied following STB method. Prior to seed sowing the salinity level was low (EC: 2.5 to 2.78 dS m^{-1}). But salinity level reached at the peak in April (EC: 8.78 and 8.96 dS m^{-1} for flat land and raised bed plot, respectively) at Hazirhat. But at Kuakata, the salinity level was much higher 1 (2.16 and 12.46 dS m^{-1}) for flat land and raise bed, respectively. The salinity intensity dropped at Patuakhali in the second year due to off and on rain during the growing period, which reflected to have higher yield (7.09- 10.10 t ha^{-1}) as against 6.84- 9.17 t ha^{-1} in the first year irrespective of treatment. The higher rates of K contributed to 29- 40% and 23-29% increased yield over control as against 17 and 14% with STB dose for Noakhali and Patuakhali, respectively, which implies the necessity of higher dose of K in salt affected soil in augmenting yield. Different combinations contributed to 19-43% and 11-42% yield benefit over control for Noakhali and Patuakhali, respectively where raised bed with higher dose of K (K_4 x M_2) gave numerically better result over other combinations. The contribution of raised bed in combination found to be 8.3 and 8.8% for Noakhali and Patuakhali, respectively. Thus application of 25-50% higher rates of K over present STB dose under raised bed method of cultivation could be useful in minimizing salt stress and optimizing yield of hybrid maize in the study area.

Effect of tillage methods and conventional compost formulated ipns package on the productivity of Radish-pea-okra-t. Aman rice cropping pattern and sustainability of soil health

The experiment was conducted at Central Research Farm of Gazipur (AEZ-28) and at RARS, Jessore (AEZ-11) during rabi 2014-2015 and 2015-2016. The objectives were to find out the suitable dose of compost and chemical fertilizers for maximizing the yield of Radish-Pea-Okra-T. aman rice pattern and to know the effect of tillage methods and compost based IPNS package on the improvement of soil health. Three were three tillage methods, such as T_1= Minimum tillage, T_2= Conventional tillage and T_3= Deep tillage: and four nutrient management practices viz. NM_1= 100% STB as per FRG, 2012 all from chemical fertilizer, NM_2= 125% STB all from chemical fertilizer NM_3: NM_1 (75% from chemical fertilizer + 25% from compost) NM_4: Native fertility. The experiment was set up in two factors Randomized Complete Block Design with 12 treatments and 3 replications. The highest root yield (23.5 and 20.0 t ha^{-1}) of radish and pod of garden pea (1.86 and 4.54 t ha^{-1}) was recorded from deep tillage, which was significantly higher over conventional tillage and minimum tillage (4-6 cm depth). The next 2 crops of the pattern okra and T. aman rice did not responded significantly to tillage depth. All 4 crops of the pattern responded significantly to nutrient management packages where the highest yield was recorded either from 125% STB dose or NM_3 (IPNS based dose). It was found that 25% increased fertilizer dose over present recommendations (FRG, 2012) is required for maximizing the yield. But IPNS approach formulated preferably with conventional compost having 75: 25 inorganic: organic ratio may save the requirement of 25% chemical fertilizer without yield reduction. Deep tillage produced higher yield, which was almost similar with conventional tillage when it combined with compost formulated IPNS package. Radish equivalent yield (REY) varied from 23.31 to 61.02 t ha^{-1} at Joydebpur and 35.80 to 68.73 t ha^{-1} at Jessore where the highest REY was observed from T_3 x M_2 which was closely followed by T_3 x M_3 and the lowest in T_1 x M_4. The experiment is in progress with second cycle where seventh crop, okra is in fruit setting stage till the preparation of the present report.

Effects of different soil moisture regimes and nutrient management on soil physical properties and yield of broccoli

A field experiment was carried out at Central Research Farm, BARI, Gazipur during 2014-2015 and 2015-2016 cropping years to develop irrigation scheduling under proper nutrient management for higher use efficiency and yield of broccoli with observing the changes in soil properties. There were twelve treatment combinations comprising four levels of irrigation i.e. I_1: IW/CPE= 0.50, I_2: IW/CPE= 1.00, I_3: IW/CPE= 1.50 and I_4: IW/CPE= 2.00 and three levels of nutrient management i.e. NM_1: Fertilizer at STB dose, NM_2: Fertilizer @ 80% of STB dose from inorganic fertilizer and rest 20% from organic manure, NM_3: Fertilizer @ 120% of STB dose. The 2 factors experiment was set up in a randomized complete block (RCB) design with 3 replications. Different soil moisture regimes showed significant variations on the yield and yield attributes of broccoli and significantly the highest yield of broccoli was obtained from I_3 (IW/CPE ratio=1.50) where the water use efficiency was maximum (0.9 cm^{-1}). The lowest yield was found in I_1 (IW/CPE ratio=0.50). Among the nutrients, IPNS based dose of fertilizers gave significantly highest yield of broccoli, which was statistically similar to 120% STB based dose. The lowest yield was obtained from STB fertilizers dose using present recommendation. Thus IPNS dose may be useful in saving the need of 20% chemical fertilizers and sustaining the yield of broccoli.

Effect of tillage methods and integrated nutrient management on soil properties and productivity of Mustard-Mungbean- T. Aus –T. Aman rice cropping pattern

A field experiments on Mustard-Mungbean-T.aus-T.aman rice cropping pattern was conducted in Grey Terrace Soil of Joydebpur under AEZ-28 during *rabi* 2015-2016 to observe the effect of tillage practices and integrated nutrient management on soil properties and to increase the productivity of the said cropping sequence. There were 3 types of tillage such as minimum tillage (T_1), conventional tillage (T_2) and deep tillage (T_3). In addition, 4 fertilizer packages such as 100 % STB dose (NM_1), 125 % STB dose (NM_2) and 100 % STB formulated with cowdung based IPNS (NM_3) and without fertilizer (NM_4) were studied in a two factor RCB design with 12 treatments and 3 replications. Both tillage and nutrient management packages produced significantly higher seed yield of mustard. Deep tillage and IPNS based nutrient management (T_3M_3) gave the highest yield (1.62 t ha^{-1}) in case of mustard but deep tillage and 125% STB dose (T_3M_2) gave the highest yield (990.2 kg ha^{-1}) for mungbean. The experiment is in progress with third crop, T. Aus rice is in vegetative stage and fourth crop T. Aman is followed.

Note: NM=Nutrient management and T=Tillage

Effect of tillage and residue management in soil moisture retention and productivity of chickpea-t.aman rice cropping pattern in barind soil

A field trial was conducted at the farmer's field of FSRD site Kadamshahar, Godagari, Rajshahi during 2015-16 with an objective to observe the effects of tillage and residue management on soil moisture conservation and productivity of crops under Chickpea- T. Aman rice cropping pattern. The experimental site represents Deep Grey Terrace Soil under High Barind Tract (AEZ-26). The trial was set up in split plot design with three replications. Three tillage options viz. (i) ST = Strip tillage (ii) BP = Bed planting and (iii) CT = Conventional tillage in combination with three crop residue management practices, viz. (i) R_0 = no residue, (ii) R_1=15% residue and (iii) R_2= 30% residue retention were employed in this study. The bed planting (BP) system gave the highest yield of chickpea (1.23 t ha^{-1}) followed by ST and lowest in CT. For the first crop, chickpea the effect of residue was not studied because there was no possibility to incorporate previous rice residue for chickpea. However, the experiment is in progress with second crop T. aman rice in tillering stage till the preparation of present report.

Measurement of soil physical and chemical properties for horticulture research farm of bari

An inventory work for the measurement of soil physical and chemical properties of Horticulture Research Farm of BARI was conducted during 2015-16. A total of 51 composite soil samples maintaining 3 depths (0-20, 20-40 and 40-60 cm) were collected from Block 29 and 30 (including organic sub block) under Horticultural Research Farm of BARI, Gazipur. Upper two layers of soil represent sandy loam texture while sub soil (40-60) belongs to sandy clay loam, which reflects the intense of sand deposition due to land development with imported soil. Bulk density varied from 1.41 to 1.77 g cc^{-1} where top soil showed lower result than the sub soil. Sub-block 8 (Pathology) gave the lower bulk density. Field capacity (FC) value varied from 24.18 to 34.87% where the highest result was observed in organic sub block and the lowest in sub block 10 (Soil Science). On an average, vegetable sub-blocks showed the lower FC. The lower moisture retention in the top soil due to excessive sand might have created drainage congestion in the substratum. pH of the studied soil appeared to be practically neutral. Sub soil yielded relatively lower pH value. Organic matter content in Block 29 and 30 found to be very low with extremely poor in substratum. The top most layer of organic sub block contained reasonably good amount of organic matter. The content of total-N was very low except few top soils of organic sub block. The content of P and S was optimum to high with few exceptions. The soil retained good amount of basic cations including K. The soil also found rich in zinc, boron and other micronutrients contents. In general, sub blocks of block 30 appeared to be more fertile than sub-blocks of 29. In case of organic sub block, poultry manure treated plots retained more moisture and showed less bulk density, more field capacity, more organic matter and almost all nutrient elements than cowdung treated ones but no changes was seen for soil texture. The sandy textured soil need to manage enriching organic matter content through green manuring and composting in order to achieve congenial physical, chemical and biological environment. Deposition of further sand would deteriorate soil health.

Assessment of arbuscular mycorrhizal association in some fruit and spices plants

Rhizosphere soils of some fruit and spices plants were collected from Agricultural Research Station, Daulatpur, Khulna and Regional Horticultural Research Station, Patuakhali during 2015-2016 for counting AM spore population and determining colonization (%) in their roots. At Khulna, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 76.3 (Jamrul) to a maximum of 200.0 (Bilimbi). At Patuakhali, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 63.7 (Litchu) to a maximum of 222.0 (Amlaki). A considerable variation was observed in average spore numbers recorded in different friut and spices plants. Different fruit plants showed different percentages of root colonization by AM fungi. At Khulna, among all the fruit and spices plants, the highest root colonization (30.0%) was found in Supari and the lowest colonization (10.0%) was found in Kola, Kul, Malta, Sajna and Tejpata. At Patuakhali, among all the fruit and spices plants, the highest colonization (30.0%) was found in Amra, Cherryfal and Kul, and the lowest colonization (10.0%) was found in Litchu, Malta, Narikel and Tetul.

Effect of potato clones containing late blight resistant genes on soil microbes under confined field trials

Confined field trials of Late Blight Resistant (LBR) potato varieties were conducted at six different locations of Bangladesh to test the suitability of LBR potato crops in the country. Two clones viz. Diamant (check variety) and D-951(137) for Set-I, and SP-951 and Katahdin for Set-II were cultivated in six different parts of the country viz. Bangladesh Agricultural Research Institute Central Farm, Joydebpur; Regional Horticultural Research Station, Comilla; Regional Agricultural Research Station, Jessore; Regional Agricultural Research Station, Burirhat, Rangpur; Agricultural Research Station, Bogra and Regional Agricultural Research Station, Hathazari, Chittagong. The field trial was laid out in Paired plot with four replications for Set-I and five replications for Set-II. To know the status of microbial population in soil due to LBR potato cultivation, soil samples were collected and analyzed at initial and post harvest soil of the crop. The microbial population of the collected soils samples was counted in the Soil Microbiology Laboratory using Standard Microbiological Procedure. Data were analyzed statistically using MS-Excel and Paired t-test. The *Rhizobium*, PSB and *Azotobacter* population of initial soil ranged from 2.5×10^4 to 6.0×10^4, 2.0×10^4 to 3.0×10^4, 1.5×10^4 to 1.0×10^5, respectively. There was no significant difference between Diamant (check variety) and D-951(137) for *Rhizobium*, PSB and *Azotobacter* population of post harvest soil. The overall result indicates that in Set-I, *Rhizobium*, PSB and *Azotobacter* population ranged from 2.5×10^3 to 1.5×10^5. and in Set-II, *Rhizobium*, PSB and *Azotobacter* population ranged from 5.0×10^3 to 5.0×10^5. Late Blight Resistant of potato varieties had no detrimental effects on soil microbial population.

Decomposition characteristics of different organic materials under different soils and region

Field incubation experiments were conducted at Central Research Farm of BARI, Joydebpur, Regional Agricultural Research Station, Jessore and Wheat Research Centre, Nashipur, Dinajpur during 2015-2016 to estimate the decomposition rate of different organic materials. There were eight treatments like T_1: Rice straw, T_2: Corn straw, T_3: Wheat straw, T_4: Cowdung, T_5: Cowdung slurry, T_6: Poultry manure, T_7: Poultry manure slurry and T_8: Vermicompost. Nylon mesh bag (0.075 mm mesh size) was used in this incubation experiment. Organic materials containing mesh bag were placed horizontally in 10-12 cm soil depth. The nylon mesh bags were collected from the field during different period of time. The mass loss of organic materials were calculated over period of incubation and the decomposition rates (*k*) were estimated from their remaining C by fitting a single-pool exponential decay model over time of field incubation. Highest mass loss was occurred in crop straw and lowest in manure slurry and animal manure showed the intermediate loss. In case of C decomposition the highest decomposition rate was observed in corn straw at all the three locations where manure and manure slurry showed lower decomposition during the 6 month-period of decompositions.

Suitability study of biochar as an alternate carrier to peat for the preparation of *Rhizobium* biofertilizers

A laboratory experiment was carried out in the Soil Microbiology Laboratory of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2015-2016 to find out the suitable carrier materials for *Rhizobium* biofertilizer production as an alternate to peat. There were seven treatments viz. T_1: Rice straw based biochar, T_2: Grass based biochar, T_3: Sawdust based biochar, T_4: Groundnut straw based biochar, T_5: Lozzaboti based biochar, T_6: Wheat straw based biochar and T_7: Peat. BARI RGm-901 (a *Rhizobium* strain isolated for soybean, *Glycine max L.*) was selected as a *Rhizobium* strain for this experiment. Among the different carriers, sawdust based biochar recorded a maximum population of $6.5^{x}10^9$ cfu g^{-1} on 30 days after inoculation followed by peat of $4.0^{x}10^8$ cfu g^{-1} of carrier and lozzaboti based biochar of $3.5^{x}10^8$ cfu g^{-1} of carrier. In addition, it was observed that all the carrier materials performed better at low temperature storage condition compared to room temperature.

Effect of biofertilizer, vermicompost and chemical Fertilizers on bushbean

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, BARI, Rahmatpur, Barisal to evaluate the effect of *Rhizobium* biofertilizer, vermicompost and chemical fertilizers on bushbean during the rabi season of 2015-2016. The crop variety was BARI Jharseem-1 and *Rhizobium* strain was BARI RPv-702. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5.0 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_7: VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_8: 100%NPKSZnB, T_9: *Rhizobium* + 100%PKSZnB which were replicated four times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. The *Rhizobium* inoculated bushbean with VC 5.0 t ha^{-1} and IPNS based PKSZnB increased nodule number (14.8 $plant^{-1}$), nodule weight (22.9 mg $plant^{-1}$) and plant height (34.1 cm). It was observed that VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB fertilizers produced the highest pod yield (16.8 pod $plant^{-1}$), stover yield (3.9 t ha^{-1}), green pod yield (15.8 t ha^{-1}, 83.7% higher over control) and seed yield (1.83 t ha^{-1}, 123% higher over control) of bushbean. This green pod yield was statistically identical with all other treatments except control treatment, VC @ 2.5 t ha^{-1} and VC @ 5.0 t ha^{-1}, and seed yield was identical with VC @ 2.5 t ha^{-1} + IPNS based NPKSZnB, VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB and VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB but differed from other treatments. This indicates that application of vermicompost @ 5.0 t ha^{-1} plus *Rhizobium* can reduce a considerable amount of chemical fertlilizers. Vermicompost exhibited better performance in bushbean. To improve soil health and to maintain it as well as to improve crop production, we have to reduce chemical fertilizer. From one year trial, it can be concluded that VC 5.0 t ha^{-1} and *Rhizobium* along with IPNS based chemical fertilizers except N may be recommended for bushbean cultivation in southwestern region, Barisal (Non–calcareous Grey Floodplain Soils under AEZ 13). Further studies and economic analysis are required for final recommendation.

Effect of biofertilizer, vermicompost and chemical fertilizers on garden pea

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, Rahmatpur, Barisal to evaluate the effect of Rhizobium biofertilizer, vermicompost and chemical fertilizers on garden pea during the *rabi* season of 2015-2016. The crop variety was BARI Motoshuti-3 and *Rhizobium* (R) strain was BARI RPs-501. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5.0 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_7: VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_8: 100%NPKSZnB, T_9: *Rhizobium* + 100%PKSZnB which were replicated four times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. The *Rhizobium* inoculated gardenpea with VC 5.0 t ha^{-1} and IPNS based PKSZnB increased nodule number, nodule weight, root weight, shoot weight, plant height, pod length, pod number stover yield, green pod yield and dry seed yield. It was observed that VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB fertilizers produced the highest green pod yield (11.2 t ha^{-1}) and seed yield (1.92 t ha^{-1}) of garden pea. This green pod yield was statistically identical with T_4, T_5, T_6 and T_9 treatments and seed yield was statistically identical with T_4 and T_5 treatments. This indicates that application of vermicompost @ 5.0 t ha^{-1} plus *Rhizobium* can reduce a considerable amount of chemical fertilizers. Vermicompost exhibited better performance in gardenpea. We have to reduce chemical fertilizer to improve soil health as well as sustainable crop production. As the yield was higher in VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB fertilizers treatment, poor farmer can adopt it. From one year trial, it can be concluded that vermicompost 5.0 t ha^{-1} plus *Rhizobium* along with IPNS based chemical fertilizer (except N) may be recommended for gardenpea cultivation in southwestern region, Barisal (Non–calcareous Grey Floodplain Soils under AEZ 13). Further studies and economic analysis are required for final recommendation.

Effect of arbuscular mycorrhizal fungi and Phosphorus on onion

A field experiment was conducted at Central Farm, Regional Spices Research Center, Magura during *rabi* season of 2015-2016 with the objectives to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on growth and yield of onion, and to reduce to use of P-fertilizer under field condition. The experiment was designed in factorial RCBD with six treatments and four replications. The onion variety was BARI Piaj-1 as test crop. Soil based arbuscular mycorrhizal (AM) inoculum and infected root pieces of the host plant were used at the rate of 1 kg soil m^{-2} in seedbed for producing onion seedlings. The treatment combinations were: T_1P_1U: 0% P × without AM, T_2P_2U: 50% P × without AM, T_3P_3U: 100% P × without AM, T_4P_1AM: 0% P × with AM, T_5P_2AM: 50% P × with AM, T_6P_3AM: 100% P × with AM. Mycorrhizal inoculation significantly increased number of leaves ($plant^{-1}$), root length (cm) root colonization (%), spore population (100 g^{-1} soil), biomass yield (t ha^{-1}) and bulb yield (t ha^{-1}). Plant height (cm), collar diameter (cm) bulb volume and weight were non-significant. The plant that received AM in nursery bed produced higher bulb yield than without AM in all phosphorus levels for onion. The highest onion yield (11.38 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 9.09% higher over 100% P without AM and 2.96% higher over 100% P with AM. The result indicates that inoculation of AM used in nursery bed can save 50% P in the field. The plant which did not receive AM in nursery bed produced lower yield in all phosphorus levels in the field. Further study in P deficient soil and economic analysis is required for final recommendation.

Effect of arbuscular mycorrhizal fungi and phosphorus on tomato

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, Jessore on 10 December, 2016 on tomato with the objectives to study the effect of combined use of arbuscular mycorrhiza and phosphorus on tomato and to reduce to use of P-fertilizer under field condition. The experiment was designed in factorial RCBD with six treatments and four replications. The tomato variety was BARI Tomato-15 as test crop. Soil based arbuscular mycorrhizal (AM) inoculum were used in seed bed for this experiment containing about 100 spores and infected root pieces of the host plant which was used at the rate of 1 kg m^{-2}. The treatment combinations were: T_1P_1U: 0% P × Without AM, T_2P_2U: 50% P × Without AM, T_3P_3U: 100% P × Without AM, T_4P_1AM: 0% P × With AM, T_5P_2AM: 50% P × With AM, T_6P_3AM: 100% P × With AM. Mycorrhizal inoculation increased plant height (cm), collar diameter(cm), root length(cm), shoot dry weight (g), root dry weight (g), root colonization (%), spore population (100g^{-1} soil), number of fruit $plant^{-1}$, fruit length (cm), fruit diameter (cm), fruit volume (cm^3), fruit weight (g $fruit^{-1}$) fruit weight (kg $plan^{-1}$) and fruit yield (t ha^{-1}). The plant that received AM in nursery bed produced higher yield than without AM in all phosphorus levels. The highest tomato yield (43.7 t ha^{-1}) was recorded in 50% P plus AM (AM was used in nursery bed). AM inoculated plant with 50% P gave 43.7 t ha^{-1} yield of tomato while non-AM inoculated with 100% P gave 36.8 t ha^{-1} yield which indicate that inoculation of AM used in nursery bed can save 50% P in the field. The plant which did not receive AM in nursery bed produced lower yield in all phosphorus levels in the field. Further study in P deficient soil and economic analysis is required for final recommendation.

Biocontrol of foot and root rot disease of grasspea (*Lathyrus sativus*) by dual inoculation with *Rhizobium* and arbuscular mycorrhiza

The present study was carried out to evaluate the effect of indigenous Arbuscular Mycorrhizal Fungi (AMF) and *Rhizobium* (R) on plant growth and their biocontrol against grasspea foot and root rot disease caused by *Sclerotium rolfsii*. The bio-control potential of these bio-agents against foot and root rot pathogen was carried out under pot culture condition using mycorrhizal species alone or in combination with rhizobial inoculum in the nethouse of Soil Science Division, BARI, Gazipur in 2014-2015 and 2015-2016. The experiment was designed in RCBD with eight treatments and four replications. Grasspea variety BARI khesari-1 was used as a test crop. Peat based rhizobial inoculum (BARI RLs-10) was used in this experiment. Soil based AM inoculum containing about approximate

252 spores and infected root pieces of the host plant was used pot^{-1}. The treatments were Arbuscular mycorrhiza (AM), *Rhizobium*, AM+*Rhizobium*, *Sclerotium rolfsii*, *Sclerotium rolfsii*+AM, *Sclerotium rolfsii*+*Rhizobium*, *Sclerotium rolfsii*+AM+*Rhizobium* and Control. Dual inoculation significantly increased germination (%), growth parameters, yield contributing characters, nodule number, nodule weight, root colonization by AM fungi and spore population in rhizosphere soils of grasspea compared to single inoculation or any other treatments. AMF species and its combination with rhizobial inoculum were significant both in the formation and effectiveness of AM symbiosis and the reduction of foot and root rot incidence in grasspea plants. The combination of mycorrhizal species and *Rhizobium* provided better results than any other tested. Use of these bio-control agents could be promoted as an active component of bio-intensive Integrated Disease Management Program (IDMP) under organic mode.

Effect of arbuscular mycorrhiza and toxic metal (as) on red amaranthus (*Amaranthus gangeticus*)

A pot experiment was carried out based on factorial randomized completely block design with four replications. Five arsenic treatments (0, 25, 50, 75 and 100 ppm) possessed arsenic level as the first factor that were treated with soils before sowing of red amaranthus seeds commonly used as a leafy vegetable in Bangladesh. The second factor consists of mycorrhizal and non-mycorrhizal treatments. The experiment was conducted in the nethouse of Soil Science Division, BARI, Gazipur in 2014-2015 and 2015-2016. Mycorrhizal plants significantly increased germination (%), vigour, yield and yield contributing characters, spore population/100 g soil, root colonization (%) and N, P, K, S uptake than non-mycorrhizal plants but significantly decreased both content and uptake of inorganic arsenic remain in soil. With increasing arsenic concentration, germination (%), vigour, yield and yield contributing characters, mycorrhizal spore population, root colonization in the rhizosphere soil, and N, P, K and S uptake decreased significantly ($p<0.01$). In contrast, with increasing arsenic concentration both content and uptake of inorganic arsenic increased significantly. The mycorrhizal plants showed as much as 11% higher increment in total growth at nursery stage, 13% higher increment in fresh yield and 11% higher increment in biomass compared to non mycorrhizal plants in 2014-2015. In contrast, the mycorrhizal plants showed as much as 10.4% higher increment in total growth at nursery stage, 20% higher increment in fresh yield and 13% higher increment in biomass compared to non mycorrhizal plants in 2015-2016. Highest mycorrhizal dependency (%) was found in treatment with highest arsenic level which suggests that the symbiotic association between the mycorrhizal fungus and the *Amaranthus gangeticus* plants was corroborate or invigorate in the arsenic environment once the association was established. The study clearly indicated that mycorrhizal inoculation could reduce the harmful effects of arsenic to the host plants, thus increase plant survival allowing the plants growth under extreme condition. Increased overall absorption capacity, absorption surface area and longevity of absorbing roots elevated heavy metal concentrations in soils resulting detoxify the environment for plant growth.

Effect of arbuscular mycorrhizal fungi on tolerance to lentil (*Lens culinaris*) at different NACL levels

A pot experiment was carried out based on factorial randomized completely block design with four replications. Five NaCl treatments (0, 1, 2, 3 and 4%) possessed NaCl level as the first factor that were treated with soils before sowing of lentil seeds overriding or pivotal pulse crop in Bangladesh. The second factor consists of mycorrhizal and non-mycorrhizal treatments. The experiment was conducted in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2014-2015 and 2015-2016. Mycorrhizal plants showed better performance in terms of germination (%), yield and yield contributing characters, nodule number, nodule weight, spore population/100 g soil and root colonization (%) than non-mycorrhizal plants. With increasing NaCl concentration, germination (%), yield and yield contributing characters, nodule number, nodule weight, spore population/100 g soil and root colonization (%) in the rhizosphere soil, decreased significantly ($p<0.01$). The study clearly indicates that mycorrhizal inoculation could reduce the harmful effects of NaCl toxicity to the host plants, thus increase plant survival allowing the plants growth under extreme condition. Increased overall absorption capacity, absorption surface area and longevity of absorbing roots elevated NaCl concentrations in soils resulting detoxify the environment for plant growth.

Effect of *Trichoderma harzianum* and arbuscular mycorrhizal fungi on growth and disease management in lentil (*Lens culinaris*)

The present study was carried out to evaluate the effect of indigenous Arbuscular mycorrhizal fungi (AMF) and *Trichoderma harzianum* on plant growth and their biocontrol against lentil foot and root rot caused by *Sclerotium rolfsii*. The bio-control potential of these bio-agents against foot and root rot pathogen was carried out under pot culture condition using mycorrhizal species alone or in combination with *Trichoderma harzianum* in the nethouse of Soil Science Division, BARI, Gazipur in 2014-2015 and 2015-2016. The result indicated that AMF alone were less effective than *Trichoderma harzianum* in improving growth and disease management. Combined inoculation resulted in a general synergistic effect on growth and disease management in lentil. AMF species and its combination with *Trichoderma harzianum* were significant both in the formation and effectiveness of AM symbiosis and the reduction of foot and root rot incidence in lentil plants. The combination of mycorrhizal species and *Trichoderma harzianum* provided better results than any other tested. Use of these bio-control agents could be promoted as an active component of bio-intensive Integrated Disease Management Program (IDMP) under organic mode. These results emphasized the need for the incorporation of suitable bioinoculant with soil inoculation for ensuring biological control, better growth and improved productivity of this important pulse crop of Bangladesh.

Integrated use of arbuscular mycorrhiza, cowdung and phosphorus in producing sweet gourd seedling

A pot experiment on the integrated use of arbuscular mycorrhiza, cowdung and phosphorus in producing sweet gourd seedlings was conducted in the Net house of Soil Science Division, BARI, Gazipur during *rabi* season of 2015-2016. Seven fertilizer treatments viz. T_1: Cowdung (CD), T_2: Arbuscular mycorrhiza (AM), T_3: phosphorus (P), T_4: CD + AM, T_5: P + AM, T_6: CD + P and T_7: CD + AM + P were studied along with T_8: Control for producing seedlings of this crop. Cowdung and TSP were used at the rate of 100 g and 1.0 g pot^{-1}, respectively. Soil based AM inoculum containing about 200 spores and infected root pieces were used in the pot of about 3 cm depth. Dry weight of seedlings, seedling height was found significantly higher with combined application of cowdung, arbuscular mycorrhiza (AM) and phosphorus compared to the remaining treatments.

Response of chickpea varieties to elite strains of *Rhizobium*

Field experiments were conducted at Regional Agricultural Research Station, BARI, Ishurdi; Regional Agricultural Research Station, BARI, Jessore; Central Farm BARI, Gazipur and OFRD, Barind, Rajshahi during 2015-2016 to study the response of inoculation with different varieties and to study the effect of different sites (Agro-ecological zones) with inoculation and varieties. Four varieties/advance lines of chickpea viz. BARI Chola-9, BCX-06001-11, BCX-05001-4 and BCX-05008-11, and rhizobial inoculum (*Rhizobium* strain RCa-220) were used in these experiments. Unit plot size was 4 m x 3 m. The experiment was designed in randomized complete block having 3 replications in each treatment. Each variety was tested with/without *Rhizobium* inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, root weight, shoot weight, seed yield and stover yield compared to non-inoculated plants almost in all the locations. Among 4 varieties/advance lines, BCX-06001-11 produced the highest nodule number at Ishurdi and Rajshahi but at Jessore and Gazipur, BARI Chola-9 and BCX-05008-11 advance line produced the highest nodule number. Nodule weight recorded by BARI Chola-9 was higher at Ishurdi and Rajshahi but BCX-05008-11 at Jessore and Gazipur. The highest seed yield (2.22 t ha^{-1} at Ishurdi, 1.76 t ha^{-1} at Jessore, 2.07 t ha^{-1} at Joydebpur and 1.76 t ha^{-1}) was observed in BCX-05008-11advance line. The highest stover yield (3.13 t ha^{-1} at Ishurdi, 2.54 t ha^{-1} at Jessore, 2.90 t ha^{-1} at Joydebpur and 2.54 t ha^{-}

^{1}) was also observed in BCX-05008-11. The interaction effect revealed that the highest seed yield of 2.62 t ha^{-1} at Ishurdi, 1.86 t ha^{-1} at Jessore, 2.38 t ha^{-1} at Gazipur and 1.86 t ha^{-1} at Rajshahi were recorded by inoculated BCX-05008-11 advance line.

Effects of *Rhizobium* and mycorrhizal inoculation on nodulation, plant characters and yield of soybean

Field experiments were conducted at Central Farm of BARI, Gazipur during 2015-2016 with the objectives to determine the effect of various phosphorus levels, nitrogen fertilizer, mycorrhizal incorporation and rhizobium inoculation on nodulation and yield of soybean. Unit plot size was 4 m x 3 m. The experiment was designed in *Randomized* complete block having 3 replications in each treatment. Among 7 different treatments, *Rhizobium* inoculant with mycorrhizal incorporation and 75% P showed the highest nodule number (48.0) and nodule weight (164.3 g plant^{-1}). The highest plant height (67.0 cm) was observed at the *Rhizobium* inoculant with mycorrhizal incorporated plot. Significantly the highest root weight (1.65 g), root length (14.6 cm) and shoot length (58.3 cm) were also found at the *Rhizobium* inoculant with mycorrhizal incorporated plot. The highest shoot weight (6.87 g) was found at the *Rhizobium* with mycorrhizal incorporation and 75% P treated plot. Significantly the highest seed yield (1.70 t ha^{-1}) and stover yield (2.65 t ha^{-1}) were found at the *Rhizobium* inoculant with mycorrhizal incorporation and 75% P treated plot.

Response of groundnut varieties to elite strains of *Bradyrhizobium*

Field experiments were conducted at Central Farm of BARI, Gazipur and Regional Agricultural Research Station, Jamalpur during 2015-2016 with the objectives to study the response of inoculation with different varieties and to study the effect of different sites (Agro-ecological zones) with inoculation and varieties. Four varieties/advance lines of groundnut viz. BARI Chinabadam-9, BARI Chinabadam-8, BINA Chinabadam-5, ICGV-96346 and rhizobial inoculum (*Bradyrhizobium* strain BARI RAh-892) were used in these experiments. Unit plot size was 4 m x 3 m. The experiment was designed in randomized complete block having 3 replications in each treatment. Each variety was tested with/without *Bradyrhizobium* inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, root weight, shoot weight, plant height, nut plant^{-1}, kernel nut^{-1},100-kernel weight, 100-nut weight, nut yield and stover yield compared to non-inoculated plants. At Gazipur among 4 varieties/advance lines, ICGV-96346 produced the highest nodule weight. Root weight and shoot weight was found the highest in BARI Chinabadam-8 and BARI Chinabadam-9. Plant height was found the highest in BARI Chinabadam-8. 100-kernel weight, stover yield and nut yield was found the highest in BARI Chinabadam-9. At Jamalpur among 4 varieties/advance lines, ICGV-96346 produced the highest nodule number, nodule weight and root weight. BARI Chinabadam-8 produced the highest shoot weight. Kernel weight of 100-nut and nut yield was found the highest in BARI Chinabadam-9. 100-nut weight was found the highest in ICGV-96346 advance line. The interaction effect revealed that the highest nodule number plant^{-1}, nodule weight and root weight was found the highest in inoculated ICGV-96346 advance line at both locations. At Gazipur and Jamalpur, the highest nut yield (2.39 t ha^{-1} and 2.29 t ha^{-1}) and stover yield (5.58 t ha^{-1} and 6.89 t ha^{-1}) was recorded by inoculated BARI Chinabadam-9.

Effect of vermicompost on micronutrient availability and carbon accumulation in soils

Field trial was conducted with cabbage 'Atlas-70' during *rabi* season of 2015-2016 at the Bangladesh Agricultural Research Institute (BARI), Gazipur (24°00′ N, 90°25′ E and 8.4 m asl) (AEZ-28) to quantify the effect of vermicompost (VC) on Cu, Fe, Mn, Zn and B availability in soils, and to determine the rate of carbon accumulation in soils from vermicompost application. There were six treatments replicated thrice where VC and composted farmyard manure (FYM) were used as the organic sources. Different nutrient packages significantly influenced the yield and yield components of cabbage. The highest cabbage head yield (92.2 t ha^{-1}) was obtained with VC @ 5 t ha^{-1} + IPNS basis RDCF application. This yield was statistically identical with the treatment where FYM was applied @

5 t ha^{-1} + IPNS basis RDCF (84.4 t ha^{-1}). The lowest yield (27.9 t ha^{-1}) was observed in control. Vermicompost exhibited better performance than FYM in combination with chemical fertilizer. The enhanced yield of cabbage in this study can be partially explained by the elevated levels of macro and micro nutrients contents in VC. Vermicompost and FYM application improved soil micronutrients availability. The Translocation Factor (TF) pattern in the present study is B>Zn>Cu>Mn>Fe and those for Biological Accumulation Coefficient (BAC) is B>Zn>Mn>Fe>Cu. Soil organic carbon status in post harvest soil showed slightly increasing trend where organic materials were used compared to inorganic fertilizer. Among the organic materials, carbon accumulation is more in VC treated plots (0.7 to 1.5 t ha^{-1}) followed by FYM (0.2 to 0.8 t ha^{-1}). It is suggested that VC @ 5.0 t ha^{-1} + IPNS basis RDCF is more favorable for higher head yield of cabbage and suitable for soil health for micronutrients availability and soil carbon accumulation in the study area of Grey Terrace Soil of Gazipur (AEZ-28).

Effects of phosphorus in reducing arsenic availability in soils and arsenic uptake by rice and maize

A pot experiment was carried out in the micronutrient experimental field of Soil Science Division of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur on December 2015 study the effect of P addition to As-contaminated soils and the consequences on As uptake of rice (Oryza sativa) and maize (Zea mays L.**)** plants. Arsenic was added to the pots at the rates of 0, 20 and 30 mg kg^{-1}, and P at 0, 30 and 60 mg kg^{-1}. Thus there were seven treatment combinations, i.e., As_0P_0, $As_{20}P_0$, $As_{30}P_0$, $As_{20}P_{30}$, $As_{20}P_{60}$, $As_{30}P_{30}$, and $As_{30}P_{60}$. The results from this study represent that no competition between phosphorus and arsenic was found even under low level of phosphorus, and an increase in plant arsenic uptake was accompanied by the phosphorus addition. Phosphorus fertilization increased total As uptake, but the increase was restricted to the root. The As concentration of root was much higher than that of shoot. Arsenic was positively and significantly correlated with P in shoot and root in rice plant and in maize the relation was less strong than that of rice plant. In –P plants for the highest As concentration in As_{30} treatment was found to be 73% in root and 27% in shoot; whereas in +P plants, at the same As concentration, 75% was in the root and 25% in shoot for rice plant. For the maize, it was 79% in root and 21% in shoot, respectively both in –P and +P plants. The results presented here indicate P supply may effect in higher As allocation to the plant parts which has practical application in soil-crop systems. The present findings suggest that phosphate application may serve as a feasible strategy for more efficient phytoremediation of arsenic contaminated soils.

Effectiveness of soil and foliar applications of zinc and boron on the yield of sweet pepper

A field experiment was carried out to study the effectiveness of soil and foliar application of micronutrients on the yield of sweet pepper (*Capsicum annuum* L.) at BARI, Gazipur, located at 23º59′26″ N and 90º24′52″ E. The micronutrients zinc (Zn) in the form of zincsulphate ($ZnSO_4.7H_2O$) as zinc source at the rate of 0.05 % and and boron (B) in the form of boric acid (H_3BO_3) at the rate of 0.03% were applied as foliar spray at three different stages of plant growth i.e (i) before flower initiation; (ii) after fruit set when it becomes approximately marble sized; and (iii) at 20 days interval of second spray. The sweet pepper yield and its contributing yield traits were significantly affected by foliar fertilizer treatments as against soil application of B and Zn fertilizers. Among various treatments, foliar application of Zn (0.05 %) + B (0.03%) produced maximum fruit yield (7901 kg ha^{-1}) while the control no use of Zn (0.0) and B (0.0) produced minimum (3978 kg ha^{-1}) and it was statistically differed with soil application of B and Zn @ 2 and 6 kg ha^{-1} (T_5), respectively. The increment of yield was 13.3 to 98.6% and 32.4 to 58.5%, respectively, over control and soil application.

Heavy metal content in different vegetables grown in industrially polluted and non-polluted areas

The content of four toxic heavy metals, lead (Pb), cadmium (Cd), nickel (Ni), and chromium (Cr) in three popular leafy vegetables namely kangkon ((*Ipomoea aquiatica*) indian spinach (*Basella alba* L., *B. rubra* L), and taro (*Colocasia esculenta*) and in the rhizosphere soils of the respective crops from two locations viz, waste water-irrigated and clean water-irrigated areas were assessed using atomic absorption spectrophotometer. Regardless of locations, there were significant differences (P <0.05) in the average Pb, Cd, Ni, and Cr concentrations in different vegetables species and the soils in which they were grown. The accumulation of metal in the plants was two to three folds higher at waste water-irrigated site compared to concentrations were recorded at clean water-irrigated site. The mean value of metals content in the roots and shoots ranged from 0.40 to 0.89, 0.35 to 0.66, 16.0 to 43.4, and 21.7 to 61.4 µg g^{-1}, respectively in Pb, Cd, Ni and Cr in waste water-irrigated site and it was 0.24 to 0.0.34, 0.25 to 0.30, 5.23 to 17.4, and 12.3 to 28.8 µg g^{-1} for clean water-irrigated site. Results of the study showed that among the three spices, the maximum concentration of Pb and Cd was found in kankon whereas Ni and Cr concentration was in Indian spinach and taro, respectively. The concentrations of metal in plants followed the rules that Cr > Ni > Pb > Cd. In soil and in the plants, the concentration of Pb and Ni not exceeding the maximum permissible limit 5 and 20 µg g^{-1}, respectively for food and food stuff provided by FAO/WHO at both the sites. But Cd and Cr exceeding the maximum permissible limit. Therefore, soil is said to be alarming to contaminate by anthropogenic inputs and requires continuous monitoring of this area.

Remediation of heavy metals polluted soil from industrial effluents polluted areas through organic amendments

This study was conducted to determine the effects of organic materials to remediate contaminated soil with heavy metals. A pot study was performed by growing Maize (*Zea mays*) in metal contaminated soil (10 kg pot^{-1}) and soils amendments with cow manure dust, poultry manure dust, vermicompost dust, fern dust, water hyacinth dust, mustard stover dust and barnyard grass dust each at 5 g kg^{-1} soil. The results showed that Pb, Cd, Ni, Cr and Co uptake by maize depended on the organic materials type. Water hyacinth dust, fern dust, mustard stover dust, and barnyard grass dust addition led to decreased metal content in maize, and this decrease was Water hyacinth dust, fern dust, mustard stover dust, and barnyard grass dust addition led to decreased metal content in maize, and this decrease was better expressed with 20.5 to 33.3% for fern dust, 17.3 to 22.0 % for water hyacinth, 18.6 to 21.3% for mustard stover dust, 17.33 to 20.5% for barnyard grass dust. Cow manure dust, poultry manure dust and vermicompost dust led to increased metal content in the maize, and this increase was 6.80 to 18.7 % for cow manure, 18.9 to 86.7 % for poultry manure and 17.4 to 16.0 % for vermicompost. The different effectiveness of organic amendment on metal uptake by maize plant could be due to the nature of organic matter where water hyacinth dust, fern dust, mustard stover dust, and barnyard grass dust were mainly originated from plant. On the other hand, Cow manure, poultry manure and vermicompost were mainly the excreta collected from cattle, poultry and earthworms. However, immobilization and phytoextraction techniques might be used to remediate soil which contaminated with heavy metal.

Arsenic contamination in soil, water and vegetables in Nilphamari and Bogra regions: health risk assessment

Ganga-Meghna-Bramhaputra basin is one of the major arsenic-contaminated hotspot in the world. To assess the level of severity of arsenic contamination and health risk, concentrations of arsenic in irrigation water, soil and common vegetables intensively cultivated and consumed by the people of Nilphamari and Bogra districts, were investigated. Arsenic concentration in irrigation water of Nilphamari and Bogra districts were 0.37 and 0.88 mg L^{-1} respectively. Arsenic concentrations of irrigation water samples were many folds higher than the WHO recommended permissible limit for drinking water (0.01 mg L^{-1}) and FAO permissible limit for irrigation water (0.10 mg L^{-1}). The mean total arsenic concentrations in the studied samples were 0.106 (range 0.002-0.655 mg kg^{-1}) and 0.504 (range 0.001-2.44 mg kg^{-1}) in Nilphamari and Bogra, respectively. Arsenic concentrations in the studied crop samples were found not to exceed the Australian food hygiene concentration limit (1.0 mg kg^{-1}) but exceeded Chinese food safety standard (0.05 mg kg^{-1}). Thus, the present study reveals that some vegetables grown in the study area are not safe for consumption, for now. But, the arsenic accumulation in the crops should be monitored periodically as the level of arsenic toxicity in the study area is increasing day by day.

Requirement of zinc and boron fertilizer for Potato-Maize-T. Aman rice cropping pattern

A field experiment on requirement of zinc and boron in Potato-Maize-T. Aman cropping pattern was carried out in Tista Meander Floodplain soil of On-Farm Research Station, Bogra (AEZ 3) during 2013-14, 2014-15 and 2015-2016. The objectives were to estimate the requirement of zinc and boron on the yield of Potato-Maize-T.aman in the pattern and to find out the optimum dose of both the elements for yield maximization. Initially four levels each of zinc (0, 2, 3 and 4 kg ha^{-1}) and boron (0, 1, 1.5, and 2 kg ha^{-1}) along with a blanket dose of $N_{170}P_{50}K_{135}S_{20}Mg_{10}$ kg ha^{-1} & cow dung 5 t ha^{-1} arranging in a randomized complete block design were employed in this study. The treatments were modified in the second crop dividing each treatment into four. Yield and yield contributing characters were influenced for all the crops with some insignificance for some treatments. Application of zinc and boron in the successive crop was found prominent for yield increment in comparison to controls. Results showed that the combination of $Zn_{3.0}B_{1.5}$ kg ha^{-1} should be applied for the successive crops for maintaining yield in the study area.

Arsenic contamination in taro of Gazipur: health risk issues

Arsenic is toxic metalloid and ubiquitous in the environment that affects around 70 countries in the world. To estimate the level of arsenic contamination and health risk of aroid/taro of Gazipur bulk amount of samples (soil, water, and taro plant) were collected from Kaliakoir, Joydevpur and Kapashia regions during 2015. Arsenic-contaminated irrigation water (0.318– 0.843 mg L^{-1}) and soil (6.6-12.6 mg kg^{-1}) considerably influenced the accumulation of arsenic in taro and its different parts. Arsenic concentrations of irrigation water samples were many folds higher than the WHO recommended permissible limit for drinking water (0.01 mg L^{-1}) and FAO permissible limit for irrigation water (0.10 mg L^{-1}). The mean total arsenic concentrations (mg kg^{-1}) in the taro samples of Kaliakoir, Joydevpur and Kapashia were 0.127, 0.164 and 0.133 respectively. The average concentration of arsenic in leaf, stem, rhizome and stolon were 0.227, 0.013, 0.151 and 0.176 mg kg^{-1}, respectively. Arsenic concentrations in the studied crop samples did not exceed the Australian food hygiene concentration limit (1.0 mg kg^{-1}) but exceeded the Chinese food safety standards (0.05 mg kg^{-1}). According to the Chinese food safety standard only the stem of arum is safe for consumption. The Taro alone was responsible for about 6.4% of health risk for arsenic toxicity.

Effect of molybdenum on the yield of cauliflower

A field experiment was carried out to study the effect of foliar application of molybdenum on the yield of cauliflower (var.Snow White) at the net house of Soil Science Division of the BARI, Gazipur (AEZ-28). The experiment was designed in RCBD with 12 treatments. The micronutrient molybdenum (Mo) in the form of ammonium molybdate $(NH4)_6Mo_7O_{24}{\cdot}2H_2O$ was applied as foliar spray at three different stages of plant growth, i) 20 days after transplanting ii) 30days after transplanting and iii) 45 days after transplanting. The treatment combinations of foliar spray of Mo were –T_1: Control; T_2: 0.025 %, T_3: 0.05 % and T_4: 0.1 % of Mo. The growth and yield of cauliflower were significantly affected by foliar spray of molybdenum. All parameters of cauliflower showed higher tendency in T_3 treatments. The highest curd weight (1.47kg) and curd yield (55.0ton ha^{-1}) were observed in T_3 treatment (0.05% of foliar spray of molybdenum). The lowest curd weight (0.98 kg) and curd yield (41.0ton ha^{-1}) was observed in T_1 treatment (no spray of molybdenum-control).Thus, foliar application of Mo on cauliflower is more effective for improving yield of cauliflower in the study area of Joydebpur, Gazipur(AEZ-28).

Zinc-iron relationship in wheat plant grown under draught stress condition

A field experiment was carried out to study the zinc-iron relationship in wheat (BARI Gom-26) plant grown under water stress condition at net house of Soil Science Division, BARI, Joydebpur, Gazipur, during November 2015 to March 2016. The experiment was designed in a split plot on sixteen treatments comprising four irrigation treatments (regular irrigation, stopping irrigation at crown root initiation, stopping irrigation at booting stage and stopping irrigation at grain filling stage) and four foliar application of zinc and iron (control, 0.05% of zinc, 0.05% of iron and 0.05% of zinc + 0.05% of iron). Zinc Sulphate Monohydrate ($ZnSO_4.H_2O$) and ferrous sulphate ($FeSO_4.H_2O$) was used as a source of Zn and Fe. The highest yield (4.01 t ha^{-1}) was recorded in stopping irrigation at grain filling stage which was identical with regular irrigation. Water stress at crown root initiation stage had the most negative effect on growth and yield. Foliar application of zinc and iron played a major role on yield and yield components of wheat at later stages of growth. The results obtained from the present research showed that iron and zinc spray developed grain yield and quality of wheat and improved the effects caused by draught stress.

Response of groundnut to boron fertilization in high Ganges river floodplain soils

Field trial on groundnut (cv. BARI Groundnut-8) was conducted in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishurdi during rabi season of 2015-2016. The objectives were to evaluate the response of boron on groundnut and to find out the optimum dose of boron for maximizing the yield. Treatments comprising six levels of boron (0, 0.5, 1.0, 1.5, 2.0 and 2.5 kg ha^{-1}) along with a blanket dose of $N_{12}P_{32}K_{42}S_{54}Zn_2$ kg ha^{-1} chemical fertilizers were used in the study. The experiment was designed in Randomized Complete Block Design having three replications in each treatment. Among the treatments, B_5 (2 kg B ha^{-1}) gave the highest seed yield (2.32 t ha^{-1}) and stover yield (5.66 t ha^{-1}). However, from regression analysis, the optimum dose of boron was found to be 2.0 kg ha^{-1} for yield maximization of groundnut in the study area of High Ganges River Floodplain Soils of Bangladesh (AEZ-11).

Response of blackgram to boron fertilization in high Ganges river floodplain soils

A field experiment was conducted in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishurdi, Pabna during *kharif-II* season of 2015-2016 with the objectives to study the response of boron fertilization to blackgram and to find out the optimum dose for yield maximization of blackgram with a blanket dose of $N_{20}P_{20}K_{35}S_{20}Zn_2$ kg ha^{-1} chemical fertilizers. There were six treatments viz. B_1: 0; B_2: 0.5; B_3: 1.0; B_4: 1.5; B_5: 2.0 and B_6: 2.5 kg Bha^{-1}in this experiment. The experiment was designed in Randomized Complete Block Design having three replications in each treatment. Among the treatments B_5 (2 kg ha^{-1}) gave the highest seed yield (1.50 t ha^{-1}). However, from regression analysis, the optimum dose of boron was found to be 1.85 kg ha^{-1} for yield maximization of blackgram in the study area of High Ganges River Floodplain Soils of Bangladesh (AEZ-11).

Effect of foliar application of zinc on wheat yield in saline areas of Satkhira

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2015-2016 to investigate the efficiency of foliar application of zinc for yield and yield components of wheat when applied at different growth stages. There were seven treatment combinations viz. T_1 = Use of fertilizers (recommended dose of fertilizers- RDF) in the form of conventional method, T_2 = 100% use of RDF in the form of foliar application, T_3= 75% RDF in the form of foliar application, T_4 = 50% RDF in the form of foliar application, T_5= 75% RDF as foliar and 25% as conventional, T_6= 75% RDF as conventional and 25% as foliar, T_7= 50% RDF as conventional and 50% as foliar. Treatments were imposed for zinc fertilizer only. The highest grain yield (4.77 t ha^{-1}) was recorded in T_3 with higher level of MBCR (2.48). The lowest level of soil salinity was (3.24 dS m^{-1}) recorded at the sowing time and the highest level of was (10.62 dS m^{-1}) at the harvesting stage.

22 ENTOMOLOGY

Survey of insect pests attacking wheat and determination of their damage potentials

Field surveyes were conducted at research field of Entomology division, BARI, Gazipur and farmers' field of Jamalpur regions during Rabi 2015-16 to record the status of insect pests attacking wheat and their natural enemies. Several insect pests viz. aphid, shoot fly, wire worm, flea beetle and stem borer were found to attack wheat crop at different growth stages, while lady bird beetle and spider were recorded as natural enemies. Low incidence of insect pests and natural enemies were observed in wheat at all the surveyed locations.

Survey of insect pests attacking maize and determination of their damage potentials

A field survey was carried out during 2015-2016 to record the status of insect pests attacking maize and their associated natural enemies at Gazipur region. Cut worm (*Agrotis ipsilon* Hufnagel), corn ear worm (*Helicoverpa* spp.) and aphid (*Rhopalosiphum maidis*) were found to attack the crop at different growth stages. Results indicated that cut worm infestation was 0.25%. However, infestation of the corn earworm was 1.85% and 1.01% leaves were infested with this pest in Gazipur region. Aphid and ladybird beetle population was found 6.35 and 1.28 nos. /plant respectively.

Development of bio-rational based management approaches against corn ear worm, *Helicoverpa zea* attacking maize

The experiment was conducted at Entomology division, BARI, Gazipur, during Rabi 2015-16 to evaluate different biorational based management approaches against corn earworm infesting maize. The result revealed that the lowest plants damage (1.33%) was attained from treatment of spraying of Spinosad (Succes 2.5 SC) @ 1.2ml/l of water treated plots and highest plant damage reduction over control (33.05%) was attained from Bt spray. However, the highest plant damage (3.32%) was found in untreated control plots. The infested cob ranged from 1.10 to 1.54% and did not differed significantly among the treatments. Hence *Helicoverpa* population was minimal during the reproductive stages, so there was no significant difference among the treatments effects on yield was found in this experiment. The highest benefit-cost ratio (9.43) was calculated from the plots of spraying with Bt.

Evaluation of different management packages against flower thrips and pod borers of mungbean both in farmer's field and on station conditions

An experiment was conducted to evaluate the different management packages against flower thrips & pod borer complex of mungbean at entomology research field of BARI, Gazipur during Kharif-I, 2016. Thrips population were significantly reduced after two spraying with Intrepid 10 EC @ 1ml/L of water at flower initiation stage and peak flowering and podding stage. Pod infestation was also lower in IPM package 2 (3.10%) resulted the highest yield (1.20 t/ha), followed by IPM package 1 plots.

Evaluation of different management packages against flower thrips and pod borers of mungbean (*Vigna radiata* L.)

Efficacy and profitability of different management packages comprising white sticky trap, bio-pesticide and synthetic insecticides were evaluated against flower thrips and pod borers of mungbean at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-1, 2016. All the treatments reduced flower infestation by thrips and pod borer infestation significantly. The highest percentage of flower infestation and thrips population reduction was observed in by installing white sticky trap + spraying of chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG) followed by farmers practice (spraying imidacloprid). Again, the highest pod borer infestation reduction was found in by installing white sticky trap + spraying azadirachtin (Bio-neem plus 1EC) + spraying with spinosad (Success 2.5 SC) treated plots followed by installing white sticky trap + spraying chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG). The highest grain yield was obtained from installing white sticky trap + spraying chlorfenapyr (Intrepid 10 SC) + spraying with emamectin benzoate (Proclaim 5 SG) but the highest return come from farmers practice (spraying imidacloprid). This might be due to the higher cost of Intrepid 10 SC and Proclaim 5 SG reduced the return and benefit. Therefore, considering the efficacy and benefit, it was seen that the evaluated IPM package could not be profitable against low level infestation of flower thrips and pod borer infestation. It could be profitable that areas where serious out break of flower thrips and pod borer occurs.

Effect of weeding on the incidence of flower thrips and pod borers of mungbean (*Vigna radiata L.)*

Effect of weeding on flower thrips and pod borer infestation in mungbean was studied at Pulses Research Center, Ishurdi, Pabna during kharif-1, 2016.Weeding in mungbean showed a significant effect against flower thrips and pod borer infestation. No weeding plots received less number of flower infestation by thrips than that of weeding at one or two times. On the other hand, weeding plots received less number of pod borer infestation than that of no weeding plots. So, it was seen that weeding in mungbean received lower pod borer infestation but higher flower thrips infestation and the reverse was true in case of no weeding. Weeding showed very significant effect in yield increase of mungbean. Weeding in mungbean increased upto 164.88% higher yield over no weeding plots but the higher cost of weeding failed to provide reasonable benefit (MBCR < 1). The highest benefit (MBCR 5.07) obtained from no weeding with insecticide (Imitaf 20 SL @ 0.5 ml/l) spraying followed by only single weeding at 12 days after sowing.

Evaluation of different management packages against flower thrips and pod borers of mungbean

An experiment was conducted to evaluate the different management packages against flower thrips and pod borer complex of mungbean at entomology research field of entomology division, Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Kharif-1, 2016. Thrips population were significantly reduced after two spraying with Intrepid 10 EC @ 1ml/l of water at flower initiation stage and peak flowering and podding stage. Pod infestation was also lower in IPM package 2 (5.41%) resulted the highest yield (1603 kg/ha), followed by IPM package 1 plots.

Evaluation of some management packages against pod borer, *Helicoverpa armigera* infesting chickpea in farmer's field and on station conditions

The experiment was conducted at research field of Entomology division, BARI, Gazipur, during rabi 2015-16 to evaluate different biorational based IPM packages against pod borer, *Helicoverpa armigera* attacking chickpea. Two varieties BARI chola 5 & BARI chola 9 were used along with the IPM packages. Results indicated that the lowest percent pod damage (1.87) and highest yield (1.62 t/ha) was recorded from BARI chola 9 along with IPM package 2 (Sex pheromone trapping + Sequential release of bio-control agents, *Trichograma evanescens* and *Bracon hebetor* + spinosad (Success 2.5SC @ 1.2 ml/litre of water).

Development of bio-rational based management approach against lentil aphid, *Aphis craccivora* koch

Management of lentil aphid using bio-rational products was studied at Pulses Research Center, Ishurdi, Pabna during rabi 2015-16. Aphid infestation in the lentil twigs was monitored regularly in the experimental plots. But no remarkable aphid infestation was observed in the twigs. So, the treatments could not be applied and the results of effectiveness of bio-rational products against lentil aphid could not be shown.

Screening of rapeseed and mustard entries (*brassica* spp.) Against aphid (*Lipaphis erysimi* kalt.)

Twenty six entries of rapeseed and mustard were evaluated against mustard aphid (*Lipaphis erysimi* Kalt.) during rabi 2015-16 at Gazipur.Three entries of B. rapa, namely BC-05115, BC-9921, BC-05117 (14.45-28.42 aphids/plant) and of B. juncea BJDH-01, BJDH-12 (6.35-8.45 aphids/plant)were attacked by less no. of aphid than the check and other entries. From the result of this experiment, it was observed that *B. rapa* entries were attacked by the highest number of aphid while *B. juncea* had the lowest aphid infestation.

Evaluation of soybean entries against major insect pest

Twenty entries of soybean were evaluated against leaf roller, hairy caterpillar, pod borer, and common cut worm infestation during 2015-16 at ORC, BARI, Gazipur. Of these, three entries namely, Colombus, GMOT -13 and AGS-205were attacked by less no. of leaf roller (3.43-5.64%), hairy caterpillar (3.00-8.15%), common cutworm (3.15-4.32%) and pod borer (0-1%) than the other entries and check variety BARI Soybean-6.

Survey, monitoring and documentation of major insect pests and their natural enemies of groundnut

The present study was carried out in the ground nut field of RARS, Jamalpur and different farmers' field under Jamalpur Sadar to monitor the insect pests and their natural enemies during Rabi season, 2015-2016. A number of insect pests were recorded during the study period. Different insect pests namely whitefly, jassid, leaf beetle and bud borer were found during the study period. Leaf beetle and bud borer were found more damaging insect pest in the ground nut.

Comparative evaluation of different ipm packages against major insect pests of brinjal

A field experiment was conducted at BARI, Gazipur during the Rabi season of 2015-16 for evaluating different bio-rational based management approaches against major insect pest of brinjal. The results indicated that, IPM package 2 Mechanical control + Diafenthuron (Polo 500SC @ 1ml/l of water) + Sex pheromone trapping + BCA release + Spinosad (Success 2.5 SC) @ 1.2ml/l of water was the most effective against major insect pest of brinjal. Significantly lowest pest populations were observed in all the IPM packages than the farmers' practice plots. The lowest fruit infestations was found in the IPM package 2 (7.12%) and 82.04 percent reduction of fruit infestation over control. The highest yield was recorded in the IPM package 2 (22.56 t/ha) treated plot followed by IPM package 1 (21.23 t/ha). The highest net return (307740/- Tk/ha) and marginal benefit cost ratio (MBCR) was obtained from IPM package 2 treated plot.

Comparative evaluation of different ipm packages against major insect pests of brinjal

The experiment was conducted during Rabi season 2015-16 at RARS, Jessore to develop effective management approach against major insect pests of brinjal. The treatments were viz. T_1 = IPM package 1: Mechanical control + Azadirachtin (Bioneem plus 1 EC) @ 1ml/l of water + Sex pheromone trapping + Spinosad (Success 2.5 EC) @ 1.2 ml/l of water. T_2= IPM package 2: Mechanical control + Difenthuron (Polo 500 SC) @ 1ml/l of water + Sex pheromone trapping + Spinosad (Success 2.5 EC) @ 1.2 ml/l of water, T_3= IPM package 3: Mechanical control + Detergent @ 5gm/l of water + Sex pheromone trapping + Emamectin benzoate 5.7 SG @ 2 g/l of water, T_4= Farmers practice: Weekly spray of Chlorantraniliprole + Thiamethoxam (Voliam Flexi 300 SC) @ 0.5 ml/l of water and T_5= Untreated control. The maximum reduction of shoot infestation over control was found in T_2 treated plot (72.75%). The maximum reduction of fruit infestation over control was found in T_2 treated plot (75.91%). The highest yield was obtained from T_2 treated plot (15.87 t/ha) and the lowest was in T_5 control plot (7.73 t/ha).The best MBCR was found in IPM package 2.

Development of a management approach against sucking pests of brinjal

A study on development of a management approach against sucking pests of brinjal was conducted at BARI, Gazipur, during *rabi* season (October, 2015 to April, 2016) with BARI Begun 8. Five treatments, viz. T_1 = Azadirachtin (Bioneem plus 1EC @ 1ml/l of water) + white & yellow sticky traps, T_2 = Difenthuron (Polo 500SC @ 1ml/l of water) + white & yellow sticky traps, T_3 = Alternate spraying of Bioneem plus 1EC and Polo 500SC + white & yellow sticky traps, T_4 = Farmers practice spraying with Thiamethoxam (Actara 25 WG @ 0.2g/l of water), and T_5 = Untreated control, in a RCB Design with three replications were applied. Alternate spraying of Bioneem plus 1EC and Polo 500SC along with white & yellow sticky traps treated plots showed significantly lowest whitefly (3.17/five leaves) and jassid (0.94/five leaves). Installation of white and yellow sticky traps in combination with alternate spraying of Bioneem plus 1EC and Polo 500SC appeared as the best approach providing highest MBCR (4.73).

Bio-rational management of red spider mite on brinjal

A field experiment was conducted at RARS, Burirhat, Rangpur during the Rabi season of 2015-16 with a view to evaluate the management approaches against red spider mite on brinjal. There were five treatments viz. T_1= application of Neem seed extract @ 50g/l of water, T_2= application of Abamectin (Vertimec 1.8EC) @ 1.25 ml/l of water, T_3= application of Propargite (Omite 57 EC) @ 2.0 ml/l of water, T_4= alternate application of T_2 and T_3, and T_5 = Untreated control. Results indicate that all the management approaches controlled red spider mite effectively over the untreated one.

Development of bio-rational management packages against major insect pests of tomato

A field experiment was conducted at the experimental field of Entomology Division, BARI Gazipur during 2015-16 to develop a bio-rational based IPM package against major insect pests of tomato. IPM Package 2 (T_2) comprising of Pheromone mass trapping + resistant variety (BARI Tomato-16) + HNPV & SNPV spray offered the lowest virus infected plants (1.27%). Fruit infestation by borer was (0.17%) in T_2 treated plot. However, the highest marginal benefit cost ratio (15.59) was obtained from management package (T_1) comprising of Pheromone mass trapping + resistant variety (BARI Tomato16).

Relative susceptibility of bari released tomato varieties to fruit borer, leaf miner and whitefly

The study was carried out at Entomology section Research Field of Horticultural Research Centre, Gazipur during *rabi* 2015-16 cropping season to check the relative susceptibility of BARI released tomato varieties to fruit borer, leaf miner and whitefly infestation. A total of eight BARI released tomato varieties were included following RCB designed with four replications. Results showed that no varieties were found even tolerant against these pests. The leafminer infestation ranged from 26.40% to36.88%. Fruit borer infestation was minimum in each varieties ranged from 0.60% to 3.97% but the relative abundance of whitefly population varied significantly and the lowest population of whitefly received from BARI tomato11 and the highest in BARI tomato 8. Again BARI tomato 14, BARI tomato 16 and BARI tomato 17 showed less susceptibility against virus disease. BARI tomato 17 gave the highest marketable yield as compared to other varieties.

Up scaling and field validation of bio-rational based integrated management package against fruit fly of sweet gourd

The experiment was conducted during Rabi season 2015-16 at RARS, Jessore. The lowest percent fruit infestation of sweet gourd was recorded in IPM package 2 (10.72 %) and the highest in Farmers practice (30.66%). The highest yield (19.02t/ha) was recorded from IPM package 2 and the lowest in farmers practice (12.20 t/ha). The percent yield increase was found 33.70 in IPM package 1 and 51.80 in IPM package 2. The highest gross return (Tk 285300) and net return (Tk 268740) were recorded from IPM package 2 and highest marginal benefit cost ratio (MBCR) (6.10) was obtained from IPM package 1.

Development of bio-rational management against pod borer (*Maruca vitrata*) attacking country bean

A field experiment was undertaken at research field of BARI, Gazipur during *kharif* 2015cropping season to evaluate several treatments against pod borer attacking country bean. Results indicated that, percent pod infestation (7.09%) by borer were significantly lowest in the Spinosad (success 2.5 SC) treated plot and this was followed by alternate spray of MNPV and Spinosad treated plot and also MNPV treated plot and there was no significant difference among them where pod infestation by borer was 7.09 %, and 7.36 %, respectively. While, the highest pod infestation (10.78%) by borer complex was offered by the control plots. Reduction of pod infestation was less than 35% over control. The highest yield obtained from the plot treated with alternate spray of MNPV and Spinosad and it was statistically similar with the plot treated with Spinosad (success 2.5 SC).

Development of bio-rational management against sucking pests of country bean

A field experiment was undertaken at research field of BARI, Gazipur during *rabi* 2015-16 cropping season to evaluate several treatments against sucking pests of country bean. Results indicated that mean thrips population was significantly lowest (4.14) in alternate spray of Bioneem plus & Intrepid treated plots followed by Intrepid10SC (4.98). Significantly highest number of anthocorid bug (0.873) were recorded in the plots treated with Intrepid 10SC and followed by alternate spray of Bioneem plus & Intrepid treated plots (0.760). Significantly highest yield (18.90 t/ha) was obtained from the plots treated with alternate spray of Bioneem plus & Intrepid. Aphid population was very low in all treatment plots.

Relative susceptibility of six country bean variety against aphids and pod borer

A study was carried out at Entomology section Research Field of Horticultural Research Centre, Gazipur during rabi 2015-16 cropping season to check the relative susceptibility of BARI released country bean varieties to aphid and pod borer. Six BARI released country bean varieties were included in this study in a randomized complete block design with three replications. Different BARI released country bean varieties showed variation in susceptibility grade to aphid and pod borer. It is evident from the results that no variety was found tolerant against aphid and pod borer but BARI Seem 6 and BARI Seem 7 showed moderately susceptible and BARI Seem 1 showed susceptible and BARI Seem 2, BARI Seem 3 and BARI Seem 4 showed very susceptibility to aphid. In case of pod borer infestation BARI Seem 7 ranked as moderately tolerant. BARI Seem 3 (0.44 larvae/pod) and BARI Seem 4 (0.81 larvae/pod) ranked as moderately susceptible. BARI Seem 1 (1.67 larvae/pod) and BARI Seem 6 (1.31 larvae/pod) ranked as susceptible in the present study. Similar susceptibility grading was also observed in case of percentage of pod borer infestation. The highest marketable yield was found in BARI Seem 1 (12.53t/ha).

Development of bio rational based integrated management packages for the major insect pests of cabbage

The study was conducted in the experimental field of Entomology Division, BARI, Gazipur during 2015-16 to develop an IPM package for insect pests of cabbage grown under different planting dates. Three IPM packages along with farmers practice were evaluated in this study. Cabbages planted at October were infested during the early part with leaf-eating caterpillars, where head infestation was 1.98-3.36% in the IPM plots. Very low infestation was observed in the November 2015 transplanting where head infestation was 1.03-1.38% in the IPM treated plots and in farmers practice it was 2.11%.

Development of bio-rational based integrated management package(s) against diamond back moth attacking cabbage

The study was conducted in the experimental field of Entomology Division, BARI, Gazipur to develop an IPM package for Diamond back moth (DBM) attacking cabbage. Two Bt strain singly and in combination with SNPV and along with farmers practice were evaluated in this study. Very low infestation was observed in the December 2015 transplanting where head infestation range was 4.36-7.95% in the Bt and Bt+SNPV treated plots.

Development of bio-rational based integrated management package(s) for the major insect pests of cauliflower

The study was conducted in the experimental field of Entomology Division, BARI,Gazipur during 2015-2016 to develop IPM package(s) for major insect pests of cauliflower grown under different planting dates. In October transplanting, curd infestation was the lowest (3.62 %) in the IPM package 3 (Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3l +SNPV @0.2g/l of water of water at 10 days interval), There was no significant difference among the tested IPM package1 (Hand picking + Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3l of water at 10 days interval) and IPM packages 2 (Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3l of water at 10 days interval). In November transplanting, IPM package 3 received lowest curd infestation (4.73%), although there was no significant difference among the tested IPM packages. In both plantings, IPM package 3 (*Spodoptera litura* lures + Bt (7841) + SNPV provided higher yield (15.22t/ha and 14.65 t/ha respectively) among the IPM treated plots.

Survey, monitoring and documentation of major insect pests of radish

A field survey was conducted at Shibganj upazilla of Bogra districts during 2015-16 to document the insect pests attacking radish and their intensity of infestation. Three insects were found to attack the crop. Common cutworm causing very minor damage but severe infestation of flea beetle was observed. Average 13.54% leaves and 20.53% root area damage by the pest was observed. Many toxic insecticides like cartap, emamectin benzoate, fipronil and imidacloprid were sprayed by the farmers maintaining no pre-harvest interval (PHI).

Identification and documentation of whitefly species and its damage severity in vegetables

An identification and documentation program of whitefly species and its damage severity in vegetables was conducted during 2015-16 at RARS, Rangpur and Gongachara upazilla of Rangpur. All identified whiteflies were *Bemisia tabaci* and its infestation varied among the vegetable crops.

Development of integrated management package's for the control of potato tuber moth (ptm) in storage Condition

The experiments were conducted in storage at TCRC, BARI, during 2015 using Cardinal variety following completely randomized design (CRD) with six treatments and three replications. The treatments were as follows: T_1 = Sex pheromone mass trapping starting from setting up experiment, $T_2 = T_1$ +Potato tuber covered with thin layer of dry sand (0.5cm sand layer) in storage, $T_3 = T_1$ + Potato tuber covered with thin layer of dry sand + Neem seed kernel @ 3:1 ratio, $T_4 = T_1$ + Potato tuber covered with thin layer of dry sand + Neem oil cake @ 3:1ratio, $T_5 = T_1$ + Potato tuber covered with thin layer of dry sand + Neem leaf powder @ 3:1 ratio, T_6= Control. Results of the present study indicated that the damage of potato tuber by PTM was the highest in control for percent of damage tuber by weight (95.47%) whereas treatment T_4 showed the lowest percent of tuber damage by weight (14.43%). The highest number of holes per tuber (8.02) was recorded in control treatment and the lowest number of holes per tuber (0.95) was found in T_4 treatment. The highest percent of rottage loss (6.93%) was found in T_2 treatment. The highest benefit cost ratio was obtained from treatment T_4 (1.99) followed by T_2 (0.77).

First record of the root aphid *(Pemphigus* Sp.*?)* on potato in Bangladesh

Potato is the 3rd most important crops in Bangladesh next to rice and wheat. It is a commercial crop in Joypurhat districts. According to DAE, the crop covers as an area of 40710 ha of land and has an annual production of 919765 metric tons during 2015-16 in Joypurhat. Among the insect pests infesting potato; cutworm, *Agrotis ipsilon*, Potato tuber moth, leaf hopper, *Amrasca biguttula biguttula*; aphid (*Aphis sp.*) and white grub are reported.

A new insect, Root aphid appeared on roots in potato at Nischinta, Joypurhat during 2015-16. The population was observed in the 2nd week of December, 2015. The pest sucks sap from the stolon under the soil. Infested stolon turns brownish from white, become decay and dry, food supply from the leaves to tuber disrupted, growth and development of tuber stopped and total production reduced. According to farmers' perception, the pest starts to attack the crop after 2nd week of January (after 2nd irrigation) and continued up to harvest. The loss caused by the pest varied 25 to 50% irrespective of varieties and locations. Local variety (Lal Pakri) had the highest infestation compared to modern varieties (Diamant, Astrix, etc.). Farmer sprayed different insecticides like Gain, Limida, and Vulture etc. at 3-5 times, but failed to control successfully. This is the location specific problem in Gonomongal, Nischinta, Khetlal, Joypurhat area.

Fig.1 Aphid on stolon

Fig. 2 Aphids on stolon

Fig. 3 Infested and healthy stolon

Fig. 4 Brownish stolon

Development of effective integrated management package of sweet potato weevil

The experiment was conducted to evaluate the effect of IPM management package in controlling sweet potato weevil during 2015- 16 at Gazipur. Among the treatments, the lowest percent of tuber damage by weight (4.88%) and maximum yield (23.81t/h) was obtained from pheromone + Earthing-up three times + Carbofuran (Furadan 5G) (T_5) treated plots which differed statistically from other treatments. The lowest mean grade crown and tuber damage also recorded in T_5 treated plots. Weevil infestation in relation to tuber size and maturity study revealed that the infestation started from the initiation of tuberisation in the control treatment. The weevil catch was significantly and positively correlated with weekly average rainfall and temperature respectively.

Efficacy of different management approach against red spider mite (*Tetranychus urticae*) of panikachu

An experiment was conducted at TCRC, BARI, Gazipur during kharif season in 2015 using variety BARI Panikachu-1 following randomized complete block (RCB) design with six treatments and three replications. The treatments were as follows: T_1 = Spraying of soap powder @ 5 gm/L of water at 10 days interval, $T_2 = T_1$+ alternate spray of Neem seed extract @ 50 g /L of water at 10 days interval, T_3 = Propergite (Omite 57EC) @ 2 ml/L of water at 10 days interval, T_4 = Abamectin (Vertimec1.8EC) @1.5 ml/L of water at 10 days interval, $T_5 = T_1$+ alternate spray of Azadiractin (Bioneem plus1EC) @ 1 ml/ L of water 10 days interval and T_6 = Untreated Control. Results indicated that the most densely population found in older leaf (59.09%) followed by young leaf (29.54%) and newly emerged leaf (11.36%). Incidence of mite population reached high (52.47mites/ 2cm^2/leaf /plant) during 4th week of April when the weekly average temperature, relative humidity and rainfall were 34.1^{o}C, 81% and 10 mm respectively. Among the five treatments significantly the lowest percent of infested leaf per plant recorded in Vertimec (28.50%) and followed by Soap powder + alternate spray of Neem seed extract treated plots. The height percent of infested leaf per plant found in control plot (92.38%) and it was significantly different from all other treatments. However, the reduction of mite population over control was maximum (70.91%) in T_4 treatment and followed by T_5 (63.71%). The yield of stolon was the highest (17.00 t/ha) in Vertimec 1.8 EC treated plots.

Integrated management of common cutworm, *Spodoptera litura* on aroid at farmers' field condition

An experiment was conducted at Jamalpur Sadar, Jamalpur during 2015-16 cropping season to find out the performance of integrated management practice against common cut worm in aroid under farmer's field condition. Crop under pheromone trap based IPM approach resulted comparative lower leaf and rhizome damage and produced higher yield than farmers practice (with insecticide).

Survey, monitoring and documentation of major insect pests of panikachu

A field survey was conducted in Joypurhat during 2015-16 to document the insect and mite pests of aroid, their nature of damage and farmers perception about their management. Several insect-mite pests viz. Common cutworm (*Spodoptera litura*), Leaf roller, Aphid, Grass hopper, Taro horn worm and red mite were found to attack the crop. Among the insect pests, Common cutworm causing serious damage compared to other pests. Other pests were occasional and caused minor damage. Results indicated that about 11.5 larva/10 plants were observed and according to farmer's perception, yield loss due to the pest was 30-35%.

Monitoring, documentation and damage severity of insect pests along with their natural enemies of minor tuber crops

A field study was conducted to monitor the status of insect pest and their natural enemy of different minor tuber crops during 2015 -16 at different locations of Bangladesh. Results indicated that mealy bug was observed only at maturity stage at Gazipur (8.35 per 5 leaves) and no harmful insects were found at Bandarban and Rangamati area at seedling or vegetative stage of cassava but grasshhopper was appeared on cassava plant during maturity stage. The mean number of grasshoper per plant was 0.02 and 0.01at Bandarban and Rangamati respectively. Three types of harmful insects and three types of natural enemies were observed in Jicama (Yam bean) at different growth stage at Gazipur location. The harmful insect bug was found in seedling, vegetative and maturity stage and the mean number of bug was 0.12, 1.18 and 2.32 respectively. Red mite and weevil were also found only at maturity stage of Yam bean and the mean population was 12.49/2cm^2/leaf and 0.01/plant respectively. On the other hand, natural enemy per plant such as -bumble bee, wasp and black ant were only found at maturity stage and their mean population was 0.6, 1.00 and 9.64 per plant respectively. There was no harmful insect and natural enemy were found both in yam and Elephant foot yam at Jessore and Gazipur location.

Development of bio-rational based management approach against mango hoppers, *Idioscopus* spp.

Field experiment was carried out following randomized complete block design with 4 treatments and 3 replications during the mango season 2016 at fruit farm, HRC, BARI, Gazipur to find out an effective bio-rational based management option for the control of mango hopper. Results indicated that spraying of *Beauveria bassiana* @ 5.0g/litre of water within 10 days of flowering and spraying of Bio-neem plus (Azadiractin) @ 1.0ml/litre of water + Indofil M-45 @ 2.0g/litre of water at pea stage of fruit growth was found the most effective for the control of both nymph and adult population of mango hopper and provided the highest MBCR (1.12) and fruit retention (168.9%) at mature stage over untreated control.

Development of insecticide based management against mango hoppers, *Idioscopus* spp.

Field trial to evaluate the efficacy of some chemical insecticides for the management of mango hoppers (*Idioscopus* spp.) was done during the mango season 2016 at fruit farm of HRC, BARI, Gazipur, Bangladesh. Three insecticides, namely imidacloprid (Confidor) 70WG, lambda-cyhalothrin (Karate) 2.5EC and Cypermethrin (Ripcord) 10EC were evaluated at pre-determined doses. The fungicide, mancozeb (Indofil M-45) was added in all the treatments (except control) during spray applications. Two sprayings, the 1st within 10 days of flowering and the 2nd at pea stage of the fruit growth (after 35 days of the 1st spray application) were done. Results indicated that all the tested insecticides were very much effective in reducing adult and nymph population of mango hoppers. Considering increased percentage of fruit retention and marginal benefit cost ratio (MBCR), insecticidal treatments are arranged from higher to lower efficacy as: Confidor 70 WG > Ripcord 10EC > Karate 2.5EC.

Development of bio-rational based management approach against mango leaf hopper, *Idioscopus* spp.

A field experiment was carried out during the mango season 2016 at Regional Horticulture Research Station (RHRS), Chapainawabganj to find out an effective bio-rational based management option for the control of mango leaf hopper. Results revealed that spraying of *Beauveria bassiana* @ 5.0g/litre of water within 10 days of flowering (1st spray) and spraying of Azadirachtin (Bio-neem plus 1.0 EC) @ 1.0ml/litre of water + Mancozeb (Indofil M-45) @ 2.0g/litre of water at pea stage of fruit growth (2nd spray) was found the most effective option for the control of both nymph and adult populations of mango leaf hopper and provided the highest fruit retention (121.2%) at mature stage and the highest marginal cost benefit ratio (1.69). Two sprays of Azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/litre of water + Mancozeb (Indofil M-45) @ 2.0g/litre of water offered satisfactory reduction of both nymph and adult population of mango hopper and provided fruit retention 84.4% at mature stage with the 2nd highest marginal benefit cost ratio (1.55). Gradual increase in number of both adult and nymphs of mango hopper was found in control treatment.

Development of insecticide based management approach against mango leaf hopper, *Idioscopus* spp.

A field experiment was carried out during the mango season 2016 at Regional Horticulture Research Station (RHRS), Chapainawabganj to find out an effective insecticide based management option for the control of mango leaf hoppers. All of three insecticides tested viz. imidacloprid (Confidor 70WG) @ 0.2g/litre of water, lambda-cyhalothrin (Karate 2.5 EC) @ 1.0ml/litre of water and cypermethrin (Ripcord 10EC) @ 1.0ml/litre of water were found the effective for the control of both nymph and adult population of mango leaf hopper over pre-treatment populations. Gradual increase in number of both adult and nymphs of mango hopper was found in control treatment. However, Confidor 70WG @ 0.2g/litre of water provided the highest fruit retention (161.17%) over control followed by Karate 2.5 EC (127.83%) and Ripcord 10EC (116.67%). The highest marginal benefit cost ratio was also obtained from Confidor 70WG (2.73) followed by Karate 2.5EC (2.41) and Ripcord 10EC (2.09). Considering the increased fruit retention and marginal benefit cost ratio the insecticidal treatments applied can be arranged from higher to lower efficacy as: Confidor 70WG>Karate 2.5EC >Ripcord 10EC.

Survey, collection and identification of different pollinators of mango

A research work on the pollinator of mango was conducted at Fruit Research Station (FRS), Binodpur, Rajshahi during February to March 2016 to know about the pollinators visited in the mango orchard during flowering stage. Results indicated that the highest number of pollinator species of mango were recorded from the order Diptera followed by Hymenoptera. The highest number of syrphid fly (35.69), house fly (7.92), blow fly (3.62) and flower fly (2.46). The syrphid fly was the most efficient pollinator due to its frequent appearance during flowering period. The highest numbers of insects were observed as a pollinator or visitor at the first half of the day (8:00 am to 11:00 am). No fruits were observed in completely bagged panicles (without any pollinator).

Efficacy of different types of baggs for management of mango fruit fly, *Bactrocera dorsalis* attacking mango

An experiment was conducted on the fruit fly, *Bactrocera dorsalis* of mango at Fruit Research Station (FRS), Binodpur, Rajshahi during mango season 2016 to develop a suitable management option(s) following randomized complete block design with 8 treatments and 3 replications. The treatments were as follows: T_1 = bagging by polythene bag; T_2 = bagging by butter paper bag; T_3 = bagging by brown paper bag; T_4 = netting by mosquito net; T_5 = mosquito net banded by bokrom; T_6 = bagging by Chinese brown paper bag; T_7 = bagging by Chinese white paper bag and T_8 = untreated control. Results showed that the percent infestation was the highest (24.00%) in untreated control treatment. The infestation was found nil in plants where bagging were done (except bagging by mosquito net which caused 5.33% infestation). All types of bagging tested in this experiment showed the best result with 100% infestation reduction over control (except bagging by mosquito net). The highest gross margin was noticed in T_1 (Tk. 7,78,860.00) and the lowest in T_8 (6,61,000.00). The highest MBCR was found in treatment T_1 (2.29) and the lowest in T_4 (0.78) treatment.

Survey, collection and identification of different pollinators of litchi

A research work on the pollinator of litchi was conducted at Fruit Research Station (FRS), Binodpur, Rajshahi during February to April 2016 to document and identify the pollinators of litchi during flowering stage. Results indicated that the highest number of pollinator species of litchi were recorded from the order Diptera (4) followed by Hymenoptera (1). In BARI litchi 1, the insect population (number/panicle) was the highest (1.15) of syrphid fly in decreasing order of population were honey bee (1.03), flower fly (0.73), blow fly (0.38) and house fly (0.25). In Bombai litchi variety, the highest (2.44) of honey bee in decreasing order of flower fly (0.76), srphid fly (0.58), blow fly (0.10) and house fly (0.05). In Dinajpuri litchi, the highest (2.42) of honey bee in decreasing order of syrphid fly (0.46), flower fly (0.36), blow fly (0.09) and house fly (0.06). The highest number of insect was observed as a pollinators/visitor at the first half of the day.

Suceptibility of different varieties of litchi to litchi mite, *aceria litchi* keifer

Studies were conducted in the litchi orchard of Fruit Research Station (FRS), Binodpur, Rajshahi duuring 2015-16 to determine the susceptibility of nine different varieties/cultivars of litchi to litchi mite (*Aceria litchi*). The highest leaf infestation (14.87%) by mites was recorded in bombai litchi which was statistically identical to Green, BAU Litchi 1, BARI litchi 1, Bedana, China-3 and followed by Mojaffarpuri. While the lowest leaf infestation (4.24%) was found in Dinajpuri.

Efficacy of different control measures against litchi mite, *Aceria litchi* keifer

The experiment was conducted at Fruit Research Station (FRS), Binodpur, Rajshahi duuring 2015-16 to develop a suitable management approach against litchi mite. Management approach comprising of pruning of infested foliage twice + one spray with abamectin (Vertimec 1.8EC) @ 1.5ml/litre of water appeared to be the best offering 86.11% leaf infestation reduction over untreated control. The lowest infested inflorescence (2.92%) was also found in the same treatment with 71.26 % infestation reduction over control. The maximum number of marketable fruits was found in the treatment where infested foliage was pruned and Vertimec was applied and this was the lowest in control treatment.

Survey and documentation of insect pests of litchi and their management practices at farm level in ishurdi region

A survey was carried out at two locations viz. Charmirkamari and Varoimari block of Ishurdi Uapzila under Pabna district of Bangladesh during April to May 2016 to determine the attack of insect and mite pests of litchi and their management practices at the farmer's level. About 40 litchi growers of two locations of Ishurdi, Pabna were interviewed using questionnaire. Eight insect pests and one mite pest were found to infest in litchi in this area. The insects are litchi fruit borer, bark eating caterpillar, leaf eating caterpillar, shoot borer, leaf miner, aphid, snow scale, bugs and litchi mite and infested on fruits, shoot, leaves and stem of litchi. Litchi fruit borer was the most serious and destructive pest of litchi among the insect pests. Application of pesticides was found only one tool for controlling insect pests of litchi. Sixteen (16) kinds of insecticides and nine (9) kinds of fungicides were applied for controlling insect pests and diseases of litchi in a season. Seven kinds of plant growth regulator (PGR) or micronutrients were applied for litchi production in a season. Six to twelve (6-12) times application of pesticides are practiced for controlling insect pests and diseases of litchi in a season. About 22% litchi growers sprayed pesticides in 5-7 days interval and about two third (63%) farmers' sprayed pesticides at an interval of 7 to 14 days. Only 15% of the litchi growers sprayed pesticides at 14-20 days interval. Every litchi grower sprayed pesticides of their litchi orchard started from before flowering to fruit harvest. Almost all farmers (100%) applied pesticides 1-2 times at before flowering stage, 1 time at bloom stage, 3-5 times at fruiting to before colour appearance and 3-4 times at colour appearance to harvesting stage. But none of the farmer's applied pesticides at flowering stage. The intensity of use pesticides will be increased with the numbers and time of rainfall increased. Every farmer considered spraying of insecticides after every rainfall during the season. On an average of 78%, 62% and 58% of litchi growers expressed that they got advice to selection of pesticide from dealers, neighbors and extension workers, respectively. Average of 78% farmers reported that the covered their body during the pesticides application. Average of 85% farmers believed that the pesticides application is harmful to farm labourers and other persons. Litchi growers reported that on an average of 80% yield was increased by applying pesticides. On an average costs of production per hectare was Tk. 3,72,888 while the net return was of Tk. 12,39,987. Average benefit cost ratio was 3.33.

Development of management approach against litchi fruit borer, *Conopomorpha sinensis*

The study was conducted at litchi orchard of RARS, Burirhat, Rangpur during April-May 2016 to develop a suitable management approach against litchi fruit borer. Five treatments have been selected for this study viz. T_1= Bagging with nylon net of fruits, T_2= Spraying of Azadirachtin @ 1ml/ L of water, T_3= Spraying of Spinosad@ 1.2 ml/ L of water, T_4= Spraying of Cypermethrin @ 1ml/ L of water, and T_5 = Untreated control. All treatments were applied at green stage of fruit. Results showing that bagging with nylon net managed litchi fruit borer effectively is discussed.

Efficacy of different types of bagging for management of oriental fruit fly (*Bactrocera dorsalis*) attacking guava

A research work on the fruit fly (*Bactrocera dorsalis*) of guava was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi during January-August 2015 to know incidence, nature and extent of damage and effect of different control measures. Five different control approachviz bagging by polythene bag, bagging by butter paper bag, bagging by brown paper bag and bagging by mosquito net against guava fruit fly to evaluate their effectiveness. The per cent infestation was the highest (93.33%) in the untreated control. The least zero percent infestation was found in plant treated by all type of bagging except bagging by mosquito net which caused 41.66% infestation. To control the guava fruit fly all type of bagging showed the best result with 100% infestation reduction over control except bagging by mosquito net (55.36% reduction). The highest gross margin was noticed in T_1 treatment (1269600) and followed by T_2 and T_4. The lowest gross margin was observed in T_5 treatment. The highest MBCR was observed in T_1 (4.56) and the lowest was T_4 (0.53).

Study on the pest status of different insects and mite pests and their natural enemies on citrus at gazipur

A field survey was conducted at Entomology citrus research orchard at Gazipur during November 2015 to May 2016 to document the major insect pests of citrus and their natural enemies. Five different types of insects mite pest namely leaf miner, asian citrus psyllid, mealy bug in leaf and twig, thrips in flower and citrus mite in fruit were recorded in the study. Among them flower thrips and citrus fruit mite infestation was found very high up to 40.14% and 33.33% infestation respectively. The highest no. of natural enemy population was observed in BARI Lebu 3 (7.47/plant) which was statistically identical to BARI Lebu 2 (7.41).

Survey and documentation of major insect pests of citrus

The survey was carried out in Gazipur, Narsingdi, Jamalpur, Jaintapur, Akbarpur and Panchagorh areas of Bangladesh in Lemon, Lime, Pumello, Sweet orange, Mandarin and Jara lebu orchards during January-June 2016 to findout the incidence and pest status of different citrus insect pests. Results showed that the leafminer infestation was 22.50%, flower thrips 8.50% and mite 10.00% and possessed as major pest status in every locations.

Development of management strategy (ies) for citrus flat mite infestation in jara lemon

The experiment was conducted in Jara lemon orchards of Farmer at Shibpur upazila under Norsingdi district with the supervision of Regional Horticultural Research station, Shibpur, Norsingdi during February to June 2016 to findout the best control measures for managing flat mite. Results showed that T_5 (Clean cultivation+ Alternate spraying of Vertimec 1.8 EC @ 1ml /L and McVit 80 DF@ 2 g/L for 2- times at before flowering and after completion of fruit setting) treated plants showed best performance in reducing flat mite infestation and increasing marketable yield. But T_4 (Bioneem plus (Azadirachtin 1 EC) @ 1 ml/litre of water 3 times (at before flowering, after completion of fruit setting and at marble size) treated plants showed the highest marginal benefit cost ratio.

Development of management tactics against thrips (*Thrips tabaci*) in onion

Several management approaches were evaluated against thrips in onion at RSRC, Gazipur during rabi 2015-2016. BARI Onion-4 was the test crop. Treatments were T_1= White sticky trap; T_2= White sticky trap + spraying of Spirotetramet (Movento 150OD) @ 1ml/L of water; T_3= Alternate spraying of Azadirectin (Bio-neem plus 1EC) @ 1ml/L of water and Spirotetramet (Movento 150OD) @ 1ml/L of water; T_4= Alternate spraying of Spinosad (Success 2.5SC) @ 1.2ml/L of water and Spirotetramet (Movento 150OD) @ 1ml/L of water and T_5= Untreated control. The reduction of thrips population was maximum (90.33%, 91.6%, 89.09% and 77.8%) recorded from T_3 treatmentfollowed by T_4 treated plot after 42 DAT, 52 DAT, 62 DAT, and 72 DAT, respectively. These two treatments were statistically similar after all the spray. The highest bulb yield (18.74t/ha) and highest MBCR (11.26) was also obtained from T_4 treatment followed by T_3 treatment.

Evaluation of onion genotypes against thrips and iris yellow spot virus

The field experiment was conducted at SRC, Bogra during Rabi season of 2015-16 to test the performance of different onion genotypes against thrips and iris yellow spot virus. Eleven different onion genotypes (ONO252, ONO254, ONO263, ONO277, ONO278, ONO280, ONO281, ONO282, ONO284, ONO285 and ONO332) along with BARI Piaz-1, 2, 3, 4 and 5 were evaluated against thrips and iris yellow spot virus. Out of eleven genotypes, ONO332 and ONO278 recorded less than 8.50 thrips per plant and lowest iris yellow spot virus (2.40 and 5.47 per plant) with higher bulb yield (13.93 and 12.24 t/ha) were characterized as highly resistant. Genotype ONO254 recorded more than 16.90 thrips per plant and highest iris yellow spot virus (16.60 per plant) with lowest bulb yield (4.28 t/ha) were grouped into highly highly susceptible.

Development of management approach against thrips-mite complex in chilli

An experiment was carried out during 2015- 2016 in the Entomology research field of BARI, Gazipur to find out the best management approach to combat thrips-mite complex of chilli. The management approach comprising of white sticky trap + Abamectin (Vertimec 1.8EC) @1.2 ml/L of water + Azadirachtin (Bioneem plus 1EC) @ 1ml/L of water appeared as the best management option against thrips-mites complex recording the lowest thrips and mites population (2.72/five twigs and 0.33/leaf respectively). The highest yield increased (65.34%) over control as well as the highest marginal benefit cost ratio (MBCR) (5.80) was also achieved from white sticky trap + Abamectin (Vertimec 1.8EC) @1.2 ml/L of water + Azadirachtin (Bioneem plus 1EC) @ 1ml/L of water treated plots.

Development of management approach against thrips-mite complex of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2015-16 to develop an integrated management approach against thrips-mite complex of chilli. The treatments were five including control. Spraying of Abamectin (Vertimec 1.8EC) and Spinosad (Success 2.5SC) @ 1.2ml/litre of water + White sticky trap @ 40 traps/ha resulted the lowest thrips (0.86 thrips/leaf) and mite (0.97 mite/leaf) population with highest marginal benefit cost ratio of 11.92. The highest percentage of thrips (87.02%) and mite (87.32%) population reduction over control with maximum red ripe chilli yield (14.70 t/ha) was also obtained from White sticky trap + Abamectin + Spinosad. Thrips and mite populations are negatively correlated with Chlorophyll Concentration Index of leaf. However, the lowest percentage of upward (19.05%) and dounward leaf curl (21.08%) was also obtained from White sticky trap + Abamectin + Spinosad treated plot followed by White sticky trap + Azadirachtin + Abamectin (22.75% and 25.15%, respectively) while the highest percentage of upward (71.25%) and dounward leaf curl (82.38%) was obtained from untreated control. So, installation of sticky white trap along with spraying of Abamectin and Spinosad may be recommended for effective management of thrips-mite complex in chilli.

Role of intercrops for the management of chilli pests

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2015-16 to know the effect of different intercrops for the management of chilli pests. Among the different intercrops tested, chilli intercropped with garlic and carrot performed well by recording lowest population of sucking pests, leaf curl index, larval population of *Helicoverpa armigera* and *Spodoptera litura* with fruit damage. Whereas, the highest pest population of aphids, thrips, mite, leaf curl index, larval population of *H. armigera* and *S. litura* with fruit damage was observed in sole chilli crop. Mean yield data revealed that, the treatment chilli intercropped with garlic recorded highest red ripe chilli yield of 11.70 t/ha and it was statistically similar to treatment, chilli + carrot (11.30 t/ha) and chilli + coriander (9.57 t/ha) whereas, intercrop yield was highest in chilli + tomato (22.80 t/ha) followed by chilli + carrot (12.05 t/ha) and chilli + garlic (7.30 t/ha). Among the different intercrops, the highest marginal benefit-cost ratio (22.73) was recorded from chilli + garlic, followed by chilli +coriander (21.89), chilli + carrot (21.15) and chilli + tomato (20.71) whereas chilli +groundnut intercrop recorded the lowest marginal benefit-cost ratio (9.47). Predators like coccinllids were found greatly distributed in the crop having different intercrops. Chilli intercropped with garlic and coriander supported good activity of the predators. It appeared that growing intercrops in between the main crop was found advantageous in the management of chilli pest's complex besides yield benefits.

Role of border crop for the management of thrips-mite complex of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2015-16 to find out the effect of border crop for the management of thrips-mite complex and the activity of natural enemy of chilli. Among different treatments, it was found that chilli crop bordered by two rows of maize with two interventions of spray, first spray with Bioneem plus @ 1 ml per litre at 7 WAT and second spray with Difenthiuron @ 1 ml per litre at 9 WAT recorded higher yield (11.90 t/ha) with least leaf curl damage due to thrips (0.77 LCI/plant) and mites

(0.28 LCI/plant) at 13 WAT and found significantly superior to all other treatments and standard check. So, chilli crop bordered by two rows of maize with two interventions of spray, first spray with Bioneem plus @ 1 ml per litre at 7 WAT and second spray with Difenthiuron @ 1 ml per litre at 9 WAT may be recommended for effective management of thrips-mite complex in chilli.

Effect of mulching materials against chilli pests

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2015-16 to study the effect of different mulching materials against chilli pests. BARI Morich-3 were mulched with transparent polythene, dry banana leaf, black polythene, rice straw and insecticide Karate were used as a standard check. The results revealed that the mulch materials significantly affect the insect pests of chilli. Among the different mulching materials tested, chilli mulched with transparent polythene and chemical insecticide Karate performed well by recording lowest population of sucking pests and larval population of *Helicoverpa armigera* and *Spodoptera litura*. The lowest number of aphid (2.70/twig), thrips (0.37/leaf), white fly (2.15/leaf), larval population of *Helicoverpa armigera* (0.72/plant) and *Spodoptera litura* (0.45/plant) were observed from chemical insecticide Karate treated plot which was closely followed by transparent polythene mulch plot. Whereas, the highest pest population of aphids (7.52/twig), thrips (3.37/leaf), white fly (6.89/leaf) and larval population of *H. armigera* (4.74/plant) and *S. litura* (2.10/plant) were recorded when no mulch material was applied to the chilli plants. However, the maximum numbers of natural enemy like *Cheilomenes* sp. (2.85/plant) was recorded from transparent polythene mulch and the minimum numbers of these insect were recorded from chemical insecticide Karate treated plot (0.50/plant). The organic mulches like rice straw and dry banana leaf also increased the yield components of chilli. Mean yield data revealed that, insecticide Karate treated plot recorded the highest red ripe chilli yield of 12.00 t/ha and it was statistically similar with both transparent plastic mulch (11.20 t/ha) and black polyethylene mulch (10.20 t/ha). The results indicated that chilli mulch with transparent polythene or chemical insecticide Karate 2.5 EC may be recommended for effective management of pest complex in chilli field.

Effect of different sowing dates for the management of chilli pests

The field experiment was conducted at SRC, Bogra, Bangladesh during Rabi season of 2015-16 to assess the effect of varying sowing dates against insect pest of chilli. The treatments were T_1= 30 August (1st sowing); T_2= 15 September (2nd sowing); T_3= 30 September (3rd sowing); T_4= 15 October (4th sowing), T_5= 30 October (5th sowing) and T_6= 15 November (6th sowing). Sowing was done at 15 days interval from August to November. The results showed that the maximum mean aphid (9.27/leaf), thrips (10.77/leaf), mite(11.51/leaf) and fruit borer population like *H. armigera* and *S.litura* larvae **(**8.25 and 6.74/plant) were found in 15 November sowing and minimum number of those insect pest were present in 30 August sowing. Red ripe chilli yields were also found to differ in descending order as follows: 30 August (13.05 t/ha)> 15 September (12.70 t/ha)> 30 September (10.30 t/ha)> 15 October (8.41 t/ha)> 30 October (5.20 t/ha)> 15 November (3.10 t/ha). It is inferred that early sowing (30 August or 15 September) resulted in lower incidence of aphids, thrips, mite and fruit borer. Such low level of insect pest caused less crop injury which resulted in enhancing the red ripe yield of chilli. So, it is suggested that for early sowing of winter chilli the appropriate planting time may be 30 August to 15 September.

Field validation of integrated management approach of common cutworm, *Spodoptera litura* on chilli at bogra region

An experiment was conducted at the MLT site, Gabtoli, Bogra during 2015-16 to observe the performance of integrated management practice against common cut worm in chilli under farmer’s field condition. Crop under pheromone trap based IPM approach resulted comparative lower fruit damage and produced higher yield than farmers practice (with insecticide). Number of captured moth/trap was higher at initial stage and gradually decreased with the progress of season.

First record of grass demon, *Udaspes folus* on turmeric in Bangladesh

Turmeric (*Curcuma longa* L), a rhizomatous herbaceous plant of the family, Zingiberaceae is one of the most important spice crop in Bangladesh. It is used in diversified forms; its tuberous rhizomes have been used from antiquity as a condiment, as a textile dye, and medically as an aromatic stimulant. It finds a place in offerings on religious and ceremonial occasions. According to DAE, the estimated area for the crop was about 0.42 lac hectares with yield of 3.64 t/ha and production of 1.94 lac tons during 2014-15. Among the insect pests infesting turmeric; Thrips, aphid, leaf roller, rhizome fly and white grub are reported earlier.

In the study of Adaptive trial of turmeric varieties during 2014-15, a new insect, Grass Demon, *Udaspes folus* (Hesperiidae: Lepidoptera) appeared on leaves in turmeric at Patabuka, Panchbibi, Joypurhat (N 25^{0}10.095 E 89^{0}01.001). The population was observed in the 2^{nd} week of December, 2015.The full grown caterpillars were then brought out to the laboratory; reared and observed their morphology.

Larvae webs leaves with silken threads, fold the leaves into a tubular form and feed on them. The caterpillar is a light uniform leaf green color with a dark green pulsating line on the back and a relatively small, dark head (Fig. 1).. The full-grown larva is dark-green and measures 36 mm in length. The smooth green colour larva with a black head pupates in dry leaves. The pupa is long and cylindrical, watery green in colour, broadens towards the shoulders and the abdomen gradually tapers to the last segment (Fig. 2). The adult is a brownish-black butterfly with 8 white spots on forewings and one large patch on hind wing (Fig. 3, 4).

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Seasonal variation in the population density of the gall mite within the leaf gall of bay leaf

The field experiment was conducted at SRC, Bogra during May 2015 to April 2016 to study the seasonal impact on the population density of the gall mite, *A. doctersi* within the leaf galls of *C.*

tamala. Maximum number of mite per gall (78/gall) with gall size 3.0cm was recorded during the month of April then it become gradually decrease and minimum number of mite per gall (10/gall) with 2.1 cm gall size was recorded during the month of December. Mite population were positively correlated with average temperature (r=0.4475) and negatively correlated with relative humidity (r= -0.5366) and rainfall (r=-0.0685). Mite population was also positively correlated with percentage of leaf area damage (r=0.8585**).

Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on some selected vegetables and fruits

Studies were carried out at Entomology Division, BARI, Gazipur, during May 2015 to April 2016 under natural field condition in order to understand the seasonal occurrence and activity of insect pest on some selected vegetables and fruits, Monitoring was done by using sex pheromone traps of eight important pests, viz. Common cutworm (*Spodoptera litura*), *Helicoverpa armigera*, DBM (*Plutella xylostella*), Sweet potato weevil (*Cylas formicarius*), Mango fruit fly (*Bactrocera dorsalis*), BSFB (*Leucinodes orbonalis*), Cutworm (*Agrotis ipsilon*) and Cucurbit fruit fly (*Bactrocera cucurbitae*). Temperature, humidity & rainfall data was recorded during the experimental period. There was a profound effect of environment (temperature, humidity & rainfall) on population fluctuation of the specific insect pests and that was positively correlated. Less trapping of common cutworm, (*Spodoptera litura*) and *Helicoverpa armigera* were observed in the crop-zone during the experimentation period but surprisingly both pests population gradually increased in non-crop zone, which indicated that those pests have wide host range.

Assessment of the pest status and seasonal fluctuation of major insect pests of some selected vegetables and fruits

An experiment was conducted at RARS, Jamalpur to assess the present pest status and seasonal fluctuation of major insect pests of some vegetables and fruits. The major insect pests of some selected vegetables and fruits were weekly monitored through pheromone traps. Insect pest surveillance of cutworm, brinjal shoot and fruit borer,cucurbit fruit fly, mango fruit fly and sweet potato weevil showed that catching of adult moth through trapping was always higher in crop zone area than the non-crop zone area during the crop season. All the population was almost available in the non-crop zone area round the year.

Assessment of the pest status and seasonal fluctuation of major insect pests of some selected vegetables and fruits

A study was conducted to monitor the seasonal population fluctuations of major insect pests of some selected vegetables and fruits using the respective sex pheromone traps in Bogra during July 2015 to April 2016. Maximum population of *Spodoptera litura* was observed during October-December & March-April, *Leucinodes orbonalis* on February, *Bactrocera dorsalis* on February to May and *Bactrocera cucurbitae* on October-December & February. Very little catch was observed on *Helicoverpa armigera, Agrotis ipsilon and Plutella xylostella.*

Studies on the succession of insect pests and their natural enemies in some selected crops

A field study was carried out at BARI, Gazipur in seven different crops viz. tomato, cabbage, cauliflower, chilli, brinjal, mustard and soybean during November 2015 to April 2016 to document the incidence and pest status of insect pests and their associated natural enemies. At in-situ condition very less number of insect pests and natural enemies were observed in seedling stage. Results indicated that the highest number of jassid (1.83) and whitefly (2.28) were recorded brinjal. The insect population was comparatively higher in vegetative stage than seedling stage. The highest number of whitefly (5.11)/5 leaves was recorded in brinjal followed by tomato (3.67) and mustard (1.33). The highest number of aphid (3.63)/5 leaves, jassid (5.37) and whitefly (8.72) was recorded in brinjal followed by tomato during reproductive stage at in-situ condition. The highest number of total insect pest population per 2 sweeps per plot was recorded in brinjal 5.67, 15.73 and 13.47at seedling, vegetative and reproductive stage respectively. The highest number of NE population was observed in mustard (6.99/2sweep) during vegetative and in soybean (9.72) during reproductive stage at sweeping. The highest number of total insects captured in mustard (14.56 & 11.91) during vegetative and reproductive stage respectively at pitfall trapping.

Assessment of the pest status and monitoring of major insect pests of some selected vegetables

All most all crops are attack by a larger number of insect pests in Bangladesh climatic condition round the year. Continuous monitoring of those insects is essentially important to know its status on different crops. In the present study, some selected vegetables have been monitored that were availably found at RARS, Burirhat, Rangpur. The observed insect pests were aphid, whitefly, jassid, thrips, mite, epiclachna beetle etc. All sucking insects were attacked with more number on okra but whitefly was attacked more number on squash and brinjal. On the other hand, aphid infestation was found more on brinjal and country bean, though in fruiting stage, it was found more on country bean.

Assessment of the pest status and seasonal fluctuation of major insect pests of stored wheat, mung bean and maize

This study was carried out in the laboratory of Entomology Division, BARI as well as farmers' house at Gazipur during January to May 2016 to document the infestation status and seasonal fluctuation of insect pests of stored wheat, mung bean and maize. It was observed that stored wheat was infested by rice weevil and rice meal moth on the other hand and maize grain was infested by rice weevil, rice meal moth and red flour beetle. Mung bean seed was infested by only pulse beetle. Stored wheat seed infestation was started at mid-March and reached in 13.63% at the end of May. Adult rice weevil was first appeared at mid- March whereas, rice moth was first appeared at the end of April and both were reached in 8.56 and 1.37 respectively at the end of May. Stored mung bean seed infestation was started at the end of March and reached in 9.83% at the end of May. Adult pulse beetle was first appeared at the end March and reached in 7.53 at the end of May. Stored maize seed infestation was started from mid-February and reached in 35.05% at the end of May. Adult rice weevil was first appeared from mid- February whereas rice moth was first appeared at the end of April and both were reached in 8.56 and 1.37 respectively at the end of May.

Development of an integrated pest management (IPM) approach for the control of insect pests of stored wheat

This study was carried out in the laboratory of Entomology division, BARI during 2014-2015. Among the treatments Aluminum phosphide (Phostoxin 57%) tablet @ 4 tablets/ton seed provided the highest protection (7.21%) followed by Seed + neem seed powder @ 50g/Kg + sand (7.68%) and the lowest number (1.41) of adult rice weevil per 150g sample was come out from the same treatment followed by Seed + neem seed powder @ 50g/Kg + sand (1.65)

Evaluation of bio-pesticides and botanicals for the management of lac predators and their safety to lac insect

An experiment was carried out at 15 years old ber orchard of Lac Research Station, Chapainawabganj during July to October 2015 Kartiki lac crop season to evaluate several bio-pesticides and botanicals against lac predators. Results indicated that, spraying of Azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/litre of water was found the most effective in reducing *Eublemma amabilis* (76.65% reduction) and *Pseudohypatopa pulverea* (75% reduction) population over untreated control identically followed by spraying of Neem seed extract @ 10g crushed seed/litre of water reducing 72.13% *E. amabilis* and 70.15% *P. pulverea*. The highest lac yield (6.55 kg/plant) was obtained from Azadirachtin 1EC @ 1.0 ml/litre of water treated plants followed by Neem seed extract @ 10g crushed seed/litre of water treated plants (6.05 kg/plant) and Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water (5.62 kg/plant). The highest MBCR (10.57) was obtained from Azadirachtin 1EC @ 1.0 ml/litre of water treated plants followed by Neem seed extract @ 10g crushed seed/litre of water treated plants (10.49) and Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water (5.41).

Assessment of sources of lac predators, *Eublemma amabilis* and *Pseudohypatopa pulverea* in the field

The study was conducted on 4 years old jujube plants at Lac Research Station, Kallyanpur, Chapainawabganj during July to October 2015 kartiki lac crop to know the sources of lac predators in the field. The results indicated that, all the predators come either from the broodlac sticks or from other plants at the time of inoculation and attack in the following crop. Predator was absent in the netted plant inoculated by netted broodlac. On the other hand, the highest number of predators was observed in the netted plant inoculated by open broodlac followed by open plants inoculated by open broodlac.

Evaluation of mulches for enhancing lac production in ber under rainfed condition in Bangladesh

The number of final population, lac population mortality and yield of lac of different mulches were statistically significant. The highest mortality was recorded in control (88.39%) resulting in the lowest yield of lac (2.73 kg/tree). On the contrary, the lowest mortality was found in black polyethylene mulch (82.69%) resulting in the highest lac yield (5.20 kg/tree) identically followed by white transparent polyethylene (mortality 82.98% and lac yield 5.03 kg/tree). Water hyacinth mulch also produced significantly higher lac yield (3.93 kg/tree) and lower lac mortality (85.37%) as compared to control. All mulches reduced the mortality of lac insect and increased lac yield over control resulting in higher MBCR. Considering lac yield and MBCR, the black polythene was the best, identically followed by white transparent polythene.

Farmers participatory trial on the predator management of lac insect in baishakhi crop season

An experiment was carried out on 5 years old ber trees in farmer’s field at Nachole area, Chapainawabganj during February–April, 2016 baishakhi lac crop season to evaluate one bio-pesticide and one botanical against lac predators. Results indicated that, spraying of Azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/litre of water was found the most effective in reducing *Eublemma amabilis* (62.18–80.60% reduction) and *Pseudohypatopa pulverea* (62.50–72.34% reduction) population over untreated control, followed by spraying of Neem seed extract @ 10g crushed seed/litre of water reducing 58.55–70.97% *E. amabilis* and 54.02–72.34% *P. pulverea*. The highest lac yield (1.95 kg/plant) was obtained from Azadirachtin 1EC @ 1.0 ml/litre of water treated plants followed by Neem seed extract @ 10g crushed seed/litre of water treated plants (1.73kg/plant).

Pesticide toxicology

Determination of pre harvest interval for quinalphos, fenitrothion, chlorpyriphos and dimethoate in major vegetables

The study was undertaken to determine the pre harvest interval (PHI) for quinalphos, fenitrothion and chlorpyriphos in chilli; dimethoate in cauliflower, tomato and hyachinth bean depending on Maximum Residue Limit (MRL) Set by FAO/WHO. Four supervised field trials were conducted and sprayed with the recommended dose (2ml/L of water) of quinalphos, fenitrotghion, chlorpyriphos and dimethoate. Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,11and 12 days after spray (DAS). The quantities were above MRL up to 8 DAS for dimethoate in cauliflower; 7 DAS for quinalphos, fenitrothion and chlorpyriphos in chilli; 6 DAS for dimethoate in hyachinth bean; 5 DAS for dimethoate in tomato. At 10 DAS, no residue was detected from any of the tested samples except dimethoate in cauliflower. The determined PHI was 9 DAS for dimethoate in cauliflower; 8 DAS for quinalphos, fenitrothion and chlorpyriphos in chilli; 7 DAS for dimethoate in hyachinth bean; 6 DAS for dimethoate in tomato.

Quantification of residue degradation of dimethoate, quinalphos and fenitrothion in major vegetables under supervised field trial

The study was carried out to detect and quantify the left over residue of dimethoate in chilli, yard long bean and red amaranth; quinalphos in chilli and fenitrothion in yard long bean and comparison between the detected residue levels with Maximum Residue Limit (MRL) set by FAO/WHO. Three supervised field trials (one for quinalphos, one for fenitrothion and another one for dimethoate) were undertaken sprayed with the field dose (2 ml/L of water) of quinalphos, fenitrothion and dimethoate. Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 days after spray. The residue of quinalphos was detected up to 9 DAS in chilli and and the residue of fenitrothion also detected up to 9 DAS in yard long bean, of which up to7 DAS the quantities of residue were above MRL in both the vegetables (chilli and yard long bean). Quinalphos remained 0.054-0.186 mg/kg residue in chilli and fenitrothion contained 0.058-0.0106 mg/kg residue in yard long bean which were below MRL at 7 to 9 DAS in yard long bean and 8 to 9 DAS in chilli. At 10 DAS, no residue was detected. The left over residue of dimethoate was detected up to 8 DAS in which MRL values (0.2 mg/kg) were found above up to 7 DAS with 0.278 mg/kg in red amaranth, 0.461 mg/kg in yard long bean and 0.314 mg/kg in chilli (at 6 DAS). The quantities of dimethoate were decrease down to 0.034 mg/kg in red amaranth, 0.074-0.046 mg/kg in yard long bean and 0.048-0.023 mg/kg in chilli these were below MRL at 7-8 DAS. No residue was detected at 9 DAS.

Determination of pesticide residue in vegetables and fruits collected from different regions of bangladesh

The study was conducted to detect and quantify the left over residue of six commonly used pesticides (chlorpyriphos, quinalphos, diazinon, acephate, dimethoate and fenitrothion) in different vegetables like brinjal, country bean, tomato, potato, chilli, cabbage, cauliflower and fruits e. g. mango and litchi sample collected from farmers field and local market of different locations viz. Jessore, Comilla, Norsingdi, Bogra, khagrachari, cox's bazaar, Mymensingh, Rangpur, Dinajpur, Ishurdi,Gazipur and Dhaka for the comparison between the detected residue level with maximum residue limit (MRL) set by FAO/WHO. Out of 50 analyzed samples of chilli 9 samples were contaminated with dimethoate and chlorpyriphos residue. Eight samples contained single insecticide (dimethoate, chlorpyriphos) residue and 2 samples had multi product (dimethoate, chlorpyriphos) residue. About 20% had contaminated with single or multiple pesticide residues, of which 4% samples were of above MRL. Dimethoate residue found as a multiple product residue (0.0.31mg/kg) which was above MRL. A total of 72 analyzed samples of bean and brinjal, 10% of the total samples were found contaminated with chlorpyriphos, dimethoate and quinalphos residue. Most of the samples contained dimethoate residue followed by chlorpyriphos and quinalphos residue. Only 5% samples had dimethoate (0.22-0.96 mg/kg) residue which was above MRL. Among analyzed 96 mango samples, no pesticide residue was detected. In case of 120 analyzed samples of litchi, 5% of the samples had Chlorpyriphos (0.50-0.75 mg/kg), dimethoate (0.529 mg/kg) and fenitrothion (0.11-0.31mg/kg) residue which were above MRL.The presence of pesticide residue in fruits and vegetables are very alarming to human food safety. So, more study in pesticide research is needed for safe food production and processing.

Development and validation of multiple pesticide residues method in shrimp using quechers extraction and gas chromatography

A simple and efficient multiple pesticide residues analytical method using QuEChERS extraction and Gas Chromatography coupled with Electron Capture Detector (ECD) has been developed and validated for the determination of 19 organochlorine pesticides in shrimp. The method was validated by evaluating the accuracy, precision, linearity, limit of detection and limit of quantification. The average recoveries of the selected pesticides ranged from 84% to 106% with RSDr ≤ 14% in four fortification levels of 0.05, 0.1, 0.2 and 0.3 mg/Kg. The linearity was ≥0.996 for all of the selected pesticides with matrix matched calibration standards. The LOD ranged from 0.003 to 0.009 mg/Kg and the LOQ was 0.05 mg/Kg.

Decontamination of some organophosphorus pesticide residues from vegetables using washing solutions and boiling

The monitoring study was conducted in the Pesticide Analytical Laboratory of Entomology Division, BARI, Gazipur during 2015-16. To assess the consequences of different washing solutions in the removal of organophosphorus pesticide residues (dimethoate, dizinon, fenitrothion, quinalphos and chloropyrifos) in brinjal, tomato, okra, teasel gourd, bitter gourd and chilli were studied. Vegetables were divided into stacks, and each lot was dipped in 0.2% pesticide solutions separately and air dried. After 24 hours, pesticide treated samples were subjected to different decontamination methods and analysed to determine the final remaining residues after treatment using QuEChERS method by Gas Chromatograph equipped with Flame Thermaionic Detector (GC-FTD). Cumulative effect of all five household process caused substantial reduction in residues up to 86%. The results indicated that washing with running water + dipping in 2% common salt water solution (20g of common salt dissolved /Litre water) for 15 min. + washing with running water +15 min. boiling was found to be more effective in reducing all pesticides tested in a certain level when compared with other treatment solutions. This treatment could reduce 40-86% of pesticide residue. It also can be reaveled that different pesticides likely to hydrolysed in different media (alkaline or acidic) as well as in different crop. This study may help to standardize simple cost effective tactics to eliminate harmful pesticides from vegetables which could be practiced by home makers.

Detection and quantification of organochlorin pesticides residue in marketed dry fish

The study was undertaken to detect and quantify the residue of twenty organochlorine insecticides in ten different types of dry fish samples like Loitta, Kanchki, Mola, Paysha, Chanda, Churi, Chingr, Shidhol, Hangor & Chepa. These samples were collected from six region of Bangladesh like Barishal, Rangpur, Bogra, Comilla, Cox's bazar and Rajshahi. Fourty seven (47) samples of dry fish were collected and analyzed for the quantification of pesticide residues. Out of 47 dry fish, 05 dry fish were contaminated by detectable organochlorine residue**.** Mola and chepa collected from Rajshahi were contaminated with 0.412 mg/kg & 0.326 mg/kg endrin residue respectively, are in above MRL (Maximum Residue Limit). Loitta and Paysha from Bogra and Barishal were contaminated with Alpha BHC respectively. Pysha from Bogra contaminated with multi pesticide (Alpha BHC 0.048 mg/kg, Beta BHC 0.097 mg/kg and Gama BHC 0.041mg/kg), were in below MRL. Churi, Chingri, Hangor and Chanda collected from different location contained no detectable organochlorine residue.

Purity analysis of different marketed pesticide groups

The study was undertaken to determine the purity of available marketed brands of seven selected pesticide groups collected from local markets of eight different locations. The total number of pesticide brands of nine different groups was 63 and 81% of the tested brands were found more than 90% pure in terms of active ingradient (AI) presence. The purity range of about 8% of the total tested brands was 51-80%. And the remaining 11% were equal or less than 50 % pure, of which three brands contained below 16% AI.

23 SERVICES OF ASICT

Agricultural Statistics and Information & Communication Technology (ASICT) Division consists of two parts namely Agricultural Statistics (AS) and Information & Communication Technology (ICT). Both the parts have been conducting research works as well as support service activities to BARI scientists in general. Research on Agricultural Statistics and ICT have been conducting through BARI annual research program. Besides, Agricultural Statistics and ICT parts have been implementing the following services.

ICT Services

Mobile apps

A mobile apps has been developed to access easily the agro-technological information at famers door steps. A system has been also developed to the end users to get technology related question-answering through this mobile app. This app named **BARI application "কৃষি প্রযুক্তি ভান্ডার"**would be downloaded from **Google play store** and then can be used through Android base mobile in offline. Through this app farmers could communicate directly to the crops specialist.

Web information

BARI developed technologies and related information are being publishing regularly through its own web site (www.bari.gov.bd). In addition to technologies, some important issues like tender circular, job circular, journal, annual report are also hosted as and when necessary. About 211 information have been uploaded on the website during 2015-16.

E-agriculture

BARI has been started on line e-agriculture services to the beneficiaries. Any stakeholder can ask question related to agriculture with the help of on-line e-agriculture facility of BARI web site and Mobile apps. BARI have been giving services on-line feedback through website (www.bari.gov.bd) and Mobile apps to end user. About 155 queries have been received from stakeholders and feedbacks of those queries from relevant centres/divisions of BARI have been uploaded on the website and mobile apps during 2015-16.

Web based mail services

BARI has procured its own domain of email connectivity under the name "bari.gov.bd". At this moment 600 web based email addresses has been assigned under BARI domain. It has been decided to assign email address to all scientists under BARI domain gradually.

Network and antivirus maintenance

ASICT division was giving services on LAN & Antivirus maintenance especially for the head quarter scientists and officers. Rendering 24 hours internet services at BARI head quarters .At present more than 400 computers are connected with network and provided with a corporate version of antivirus. Ensuring hassle free internet connectivity ASICT division has been performing a number of network and antivirus maintenance activities. About 922 network and antivirus related maintenance work have been done during 2015-16.

Network connectivity at eight outer stations

Network connectivity through Virtual Private Network (VPN) and 1 Mbps broadband internet connection at eight outer stations such as WRC, Dinajpur; SRC, Bogra; RARS Jamalpur; RARS Ishurdi; RARS Jessore; RARS Hathajari; RARS Ramatpur and RARS Akbarpur with MoA have been established.

E-Governance through office automation software

BARI office automation is going on full swing. This office automation software is divided into five separate modules viz. Personnel Management Information System (PMIS), Training Management Information System (TMIS), Financial Management Information System (FMIS), Databank Management System (DMS) and Project Management System (PMS). Each module can be operated solely and has a options to be integrated together as per requirements.

NARS automation through BARC developed MIS software

BARC has been developed 9 modules MIS software to the NARS institutes. For globalization, besides BARI office automation software ASICT division has been taken initiative to implement the software. The nine modules are Human Resource Management Information System (HRMIS), Training Management Information System (TMIS), Research Management Information System (RMIS), Financial Management Information System (FMIS), Procurement Management Information System (PMIS), Inventory Management Information System (IMIS), Vehicle Management Information System (VMIS), Library Management Information System (LMIS) and Databank (Gene Bank).

BARI Labour Management automation

BARI labour management automation is going on full swing. At present, 53 division /section and 1349 labour information are included in this automation. This automation software is divided into three parts viz, Labour Information, Labour Salary and Labour Report. Each part can be operated solely and has a options to be integrated together as per requirements.

Geographical information system (GIS) mapping

GIS is one of the formalized computer based information systems capable of integrating data from various sources to provide information necessary for effective decision making in urban, rural and agricultural planning. Bangladesh Agricultural Research Institute (BARI) is the largest multi-crop research institute. It conducts research on more than two hundred crops. To know the crop area, crop suitability, crop modeling it is very important. For digital data base and mapping it is unparallel. ASICT division has been prepared about 21 maps for different centres/divisions based on their requirements.

Participation of ICT fair and field day

However besides services ASICT division has been participated ‘District Digital Innovation & Science Fair’ held on 21-22 January 2016 @ Rajbari, Gazipur. ASICT division has been participated two mobile apps field day held on 03 September, 2015 and 23 April, 2016 in Natitabari upazila of Sherpur district and Pirgonj upazila of Rangpur district, respectively.

Statistical services

ASICT division has been giving services on statistical analysis through computer package software such as R, SAS, CROPSTAT, SPSS etc. Some important requested analysis has been done about 24 analysis for Center/Division/Section/Others during 2015-16.

Research Outputs 2015-2016

Development of online system for data collection, documentation and mapping of mustard in chalan beel area of Bangladesh

A study was conducted during 2015-16 to build union level digital databases and maps of mustard growing areas in Chalan Beel area, using both primary and secondary data. Primary data were collected from mustard growing areas of three upazillas namely Taras of Sirajganj district and Singra and Gurudaspur of Natore district. For mustard: union, upazila, district and country level digitized maps were used in the study. Geographical Information System (GIS), Global Positioning System (GPS) and Management Information System (MIS) related Information Technology (IT) were used in this study. Total cultivable land in the study areas was 77,693ha; area and production of mustard were 8551.59ha and 10563.53t respectively.Five (5) mustard varieties were cultivated in the study areas; among them maximum 5 varieties were cultivated at Sigra and Gurudaspur; minimum three varieties at Taras. Out of 5 varieties of mustard 93.91% area was covered by two varieties Tori-7 and BARI Sarisha-14 and the rest by others. It was found that 83.12% area of mustard was covered by Tori-7 which contributed 79.53% of the total production. Average mustard yield of the study areas was 1.59 t/ha during 2015-16. A web site (www.asictbari.net) was developed for variety wise area coverage data collection of mustard as well as for other crops. This web site could be used in the smart phone.

Development and implementation of BARI labour management system

Labour Management System can manage the labour of an organization effectively and efficiently. A labour management software was developed for monitoring and controlling labour at BARI. This Labour Management System software was developed using MySQLdatabase which mainly focuses on basic operations in labour like adding new labour, updating new information, salary sheet etc. This software is a windows based application for 32-bit windows operating systems, designed to help users maintain and organize labourThis software has been designed to use for both beginners and advanced users.

Comparison of spectro-temporal signature of major agricultural crops of Bangladesh

Spectral reflectance indices provide a useful tool for monitoring crop-growing status. This study was conducted during 2015-2016 to identify the features in distinguishing spectro-temporal signature for classifying major crops. A series of spectral data were collected using spectroradiometer from different crop fields such as Potato, Wheat, and Lentil over the crop growing (Rabi) season at BARI crop meuseum. Analysis was done to assess the spectral separability of various crop types under two scenerios; scenerios 1 involved testing separability based on number of days after planting and scenario 2 involved testing separability at specific dates across the growing season. The results indicate that although crop classification could be achieved at any point during the growing season, the optimal time for separation to be in mid January. The information derived from hyperspectral radiometer seemed to possess the potentiality for monitoring the general growth status of crop field.

GIS based land suitability assessment for major crops

Crop-land suitability analysis is a prerequisite to achieve optimum utilization of the available land resources for sustainable agricultural production. Lack of knowledge on the best combination of factors that suit crop production might contribute to the low production. Therefore multi-factor analysis of different aspects of land, climate and socio-economic factors is a must to achieve the suitable crops for sustainable production. A GIS based Crop Suitability Assessment Model (CSAM) was used to assess the suitability of major crops (e.g. wheat, potato, maize, rice, etc.) in Delduar Upazila of Tangail district. Land/crop suitability was determined through multi-factor analysis of different aspects of land, climate and economic factors of the study area. The agro-edaphic and agro-climate suitability was determined separately based on the soil/land factors and climatic factors, respectively. Afterwards, land suitability (e.g. very suitable, suitable, moderately suitable, marginally suitable and not suitable) for different crops was performed through overlaying of agro-edaphic and agro-climatic suitability layers using CSAM. The model derived results provided the suitability maps of major crops(such as rice, wheat, maize, pulses and oilseeds etc.) of Delduar upazila and cropping pattern as well. Finally CSAM provided the best cropping pattern for Delduar upazila as well. This GIS based model is user-friendly and flexible application software which will be useful for agricultural scientists, planners and decision makers.

Development of geodatabase for haor region of sustainable intensification of agriculture

A study has been conducting for the development of Geodatabase of the Haor Region located in the northeastern part of Bangladesh for sustainable intensification of Agriculture. Scopes of this research include accumulation of existing geodatabase of Haor region from different sources or organizations, adding values to them, conduct new analysis and generate geospatial data from satellite imagery. To procure relevant geodata from a wide range of public/autonomous organizations including Department of Bangladesh Haor and Wetland Development, Center for Environmental and Geographic Information Services, Bangladesh Water Development Board, Institute of Water Modeling, Local Government Engineering Department, Soil Resources Development Institute, Bangladesh Agricultural Research Council, Survey of Bangladesh were approached. Some of the organizations responded positively and shared or in process to share geodata from their repository. However, most of the available geodata are not up-to-date and are of coarse spatial resolution. To generate up-to-date and of moderate spatial resolution landuse and cover map, landsat 8 multi-spectral satellite data of Rabi seasonwas classified. Extensive ground survey was conducted to accumulate primary reference data for training of classification algorithms as well as validation of classification results. Fallow kanda lands were successfully identified for a certain instance from the initial classification of landsat 8 satellite image. However, further analysis is necessary to depict the dynamic feature of temporal availability of such fallow lands and suggesting suitable agricultural crops in those lands.

Information of BARI technology at the farmers' doorstep through mobile apps

A mobile appnamed BARI application "কৃষি প্রযুক্তি ভান্ডার" was developed to make available crop production packages at the right time at farmer's doorstep in a cost effective way. The entire contents of this app are in Bangla language. BARI apps "কৃষি প্রযুক্তি ভান্ডার" has five options namely (i) Crops (ফসল), (ii) Other technology (অন্যান্য প্রযুক্তি), (iii) Query (প্রশ্ন করুন), (iv) Answer (উত্তর/মতামত) and (v) Communication (যোগাযোগ). At present about 1000 technologies hosted in the mobile apps which included oilseed crops, pulse crops, tuber crops, wheat, maize, fruits, vegetables, flower, spices crops, rice, jutes, cotton and sugarcane, etc. Any farmer can ask/inquire about related technology through query option. Answers of the queries are sent to farmer through SMS and e-mail. Answers are also stored in the feedback option which is open for public access.Thefarmer can directly contact with related specialists through communication option. Mobile apps "কৃষি প্রযুক্তি ভান্ডার" isregularly updated with maintenance and newly developed technologies are added as well. This apps can be downloaded from Google play store and Windows storeusing Android and Windows phone respectively. This apps can be used offline. The apps can also be shared with other Androidbased mobile phones using SHAREit apps even without internet.

24 Training, Communication, Publication Library and Photography Activities

Training & Communication

During 2015-2016, two scientists were sent for post doctorate, Twenty one scientists were sent for Ph.D and three for M.S/M.Sc. One hundred and nine scientists/officers were sent abroad for training/workshop/study tour/visit-meeting/conference etc. Moreover, a good number of scientists were sent to different universities in the country for Ph.D and MS degree.

Seminar

Communication section of T&C arranges seminars in various fields of agricultural research. A total of 8 seminars were organized at BARI during the year 2015-2016. Among them, three seminars were from Agronomy division, two were from Plant Breeding, two were from Horticultural Research Centre and one from Irrigation & water management division. A total of 285 participants of BARI and other organizations were actively participated in these seminars.

MoU and LoA signed

During the period of 2015-2016, BARI had signed MoU with 5 (five) organizations, LoA with 1 (one) organization and Minutes of Meeting (MM) with 1 (one) organization. All of the organizations signed MoU, LoA and MM with BARI were nongovernment voluntary organization. The purpose of the MoU and LoA were to promote collaboration between agricultural research and development and also for promotion of technology transfer to the end users.

Publication

BARI regularly publishes journal, newsletters (Bengali and English), annual report, and books & booklets on the evolved technologies in order to disseminate information to the users including farmers. Brochure, manuals, and other literatures on BARI are also being published. During the year under report, 4 issues of newsletter, brochure of the institute, annual report, a few booklets and some other literatures have been compiled, edited and published. Further, more than hundred science articles reveived from scientists of home and abroad hae been processed for publication in the journal.

BARI Central Library

A. Mandate: BARI Library is the biggest Agricultural Library aiming at fulfilling the purpose of its parent institute and is designed to help researchers providing with the information generated in and outside the country in print and electronic form at the right time. Our mandates are as follows:

- ❖ Building up a balanced and comprehensive collection in the sphere of agriculture and its allied fields based on the scientists needs with a bit focus on the generalist’s interests.
- ❖ Preparing and processing the procured materials to ensure users effectiveness.
- ❖ Making the research community aware of new information and technology collected in and organized technically.

- ❖ Maintaining contract with national and international institutes and organization and sharing the information residing on Internet.
- ❖ Participating inter-library loan and network system to serve the researchers effectively.
- ❖ Providing aid on the use of the library and helping finding, locating and evaluating the information available in the library.
- ❖ Establishing Management Information System (MIS) i.e. digital library, using library management software in the library.
- ❖ Adopting the technique of economic method to preserve and repair the collection to ensure its continued use.
- ❖ Developing the mini-libraries at the regional and sub-regional station to feed the scientists with their needed information.

B. Existing facilities: Information resources materials collected so far have been properly catalogued, classified, and organized. The Library now houses following information resource materials.

1. Existing Collection of BARI Library: 74,172

Items	Quantity
Books, Reports, Proceedings, etc.	35402
Archival collection	2670
Thesis	751
Periodicals (bound in book form)	4247
Journal issues	23994
Journal titles	621
Newsletter titles	502
Bulletin titles	108
Pamphlets	567
Booklets	31
Reprint	518
Leaflets	4761

2. Information Resources added during the year 2015-2016:

a. Books, Reports, Proceedings etc. and Thesis: 306

Items	Purchased	Exchange	Gift /Complimentary	Total
Books	163	11	58	232
Research reports, project reports & proceedings	-	09	26	35
Thesis (MS & Ph.D.)	-	-	39	39

b.	**Serial Publications (printed form)**	**Titles**	**Issues**
	Journals:	***25***	***99***
	Newsletters, bulletins etc:	**41**	**88**

Items	Purchase	Exchange	Gift /Complimentary	Total
Journals:	-	46	53	99
Newsletters:	-	11	67	78
Bulletins:	-	2	8	10

3. Document Processed for Services:

SI No.	Procured material processed	No.
01	Document Accessioned	306
02	Catalogued & Classified and pasted with call numbers, book pockets and due slips	306

4. Services Provided to the Scientists:

Sl No.	Services provided to the Scientists	Number
1.	Article downloaded from Online journal (April 2016)	7643
2.	Documents Charged/Discharges	567
3.	Users Referenced	754
4.	Internet Services to the Scientists & Students	80
5.	Number of photocopies made	12540
6.	Publication Distributed (Journal, Newsletter & Report) in Exchange & Complimentary)	320
7.	Correspondence made	211

5. Library Database: 535 thesis have been uploaded on to the LMIS Module, National Agricultural Technical Project (NATP). Our Library database links are as follows:

* 128.15.10.17
* 128.15.10.41

6. Online Browsing Facilities Developed: Library has established online accesses to the subscribe Information resources of 1. Springerlink, Indianjournals, Wiley, Ebscohost, Oxford Journals, Cambridge & World Bank and complementary sources are 1. AGORA & HINARI, DOAJ Scientists can have full texts access to thousands of journals published across the world except a few countries through this Online Access.

Photography Section

Activities of photography Section during 2015-2016

Sl. No	Activities	Number
1	Photograph exposed in Digital Camera	30,000 above
2	Photo Editing	18,500 above
3	Video Recording programme	43

25 BUDGET

Fund for the Institute was received from development and revenue budget of the Government of Bangladesh. The development budget was made available through the annual development program (ADP) for the on-going development projects under the Institute (Table 2). Out of total ADP allocation of Tk. 9750.37 lakh. The GoB funding was Tk. 7645.76 lakh, which was offered by different aid-giving agencies as Project Aid (PA)

Besides, an amount Tk. 23000.59 lakh was made available from the revenue budget to meet the recurring expenditure of the already complied projects of the Institute (Table)

Table-1: Budget provision of BARI for 2015-2016 (in lakh Tk.)

Total	GOB Head			Project Aid (PA/RPA	Capital Head	Revenue Head		Total
	ADP	Revenue	Total			ADP	Revenue	
32750.96	**7645.76**	**23000.59**	**30646.35**	**2104.61**	**5592.76**	**3804.98**	**23000.59**	**26805.57**

Table-2: Development Budget (Annual Development Programme) of BARI for 2015-2016 (in lakh Tk.)

Name of Projects	Total	GOB	PA	Capital	Revenue		Total
					Pay & Allow.	Contingency	
Development Projects							
Tuber Crops Development Project (BARI Part)	301.00	301.00	0	0	0	301.00	301.00
Enhancing Quality Seed Supply	1969.57	333.00	1636.57	1607.00	20.25	337.09	357.34
Continuation and Expansion of Pesticide Research in Pesticide Analytical Laboratory at BARI	95.76	95.76	0	17.76	3.55	50.45	54.00
Mujibnagar Integrated Agricultural Development Project	150.0	150.00	0	0	8.64	130.25	138.89
Integrated Agricultural Productivity Project (BARI Part)	547.04	79.00	468.04	48.00	86.25	362.36	448.61
Development and expansion of research and resaearch infrastructure of BARI	5500.00	5500.00	0	3500.00	0	1870.00	1870.00
Pirojpur-Gopalgonj-Bagherhat Integrated Agrivultural Development Project (BARI Part)	163.00	163.00	0	0	3.99	124.90	128.89

Name of Projects	Total	GOB	PA	Capital	Revenue		Total
					Pay & Allow.	Contingency	
Sytrus Development Project (BARI Part)	500.00	500.00	0	240.00	33.25	176.75	210.00
Improvement and Quality Seed Production of Wheat and Maize-2nd Phase	500.00	500.00	0	180.00	0	279.00	279.00
Strengthening of Oilseed and Pulses Research and Development in Bangladesh	24.00	24.00	0	0	0	17.25	17.25
Total :	**9750.37**	**7645.76**	**2104.61**	**5592.76**	**155.93**	**3649.05**	**3804.98**

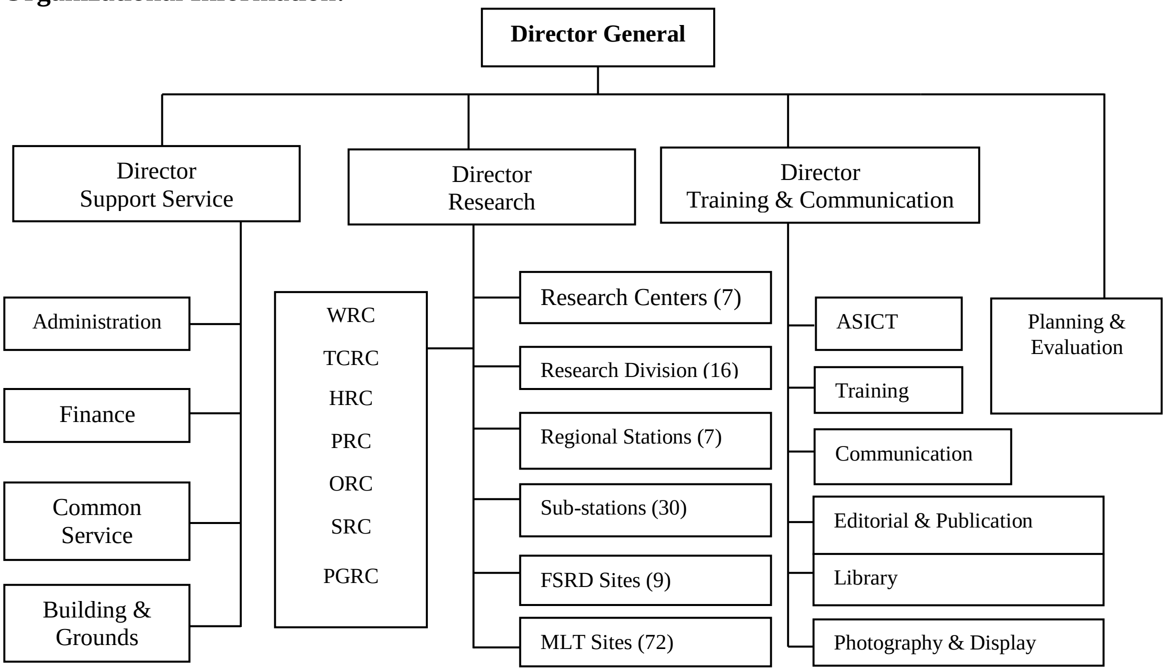
26 INFORMATION REPORT (As per Information Commission Requirements)

Institutional information:

BARI (Bangladesh Agricultural research Institute) is the largest multi-crop research institute conducting research on a wide variety of crops such as cereals, tubers, pulses, oilseeds, vegetables, fruits, spices, flowers, etc. Besides variety development, this institute carries out research on such areas as soil and crop management, disease and insect management, water management and irrigation, development of farm machinery, improvement of cropping and farming system management, post-harvest handling and processing, and socio-economic studies related to production, processing, marketing and consumption. The institute functions with the Director General as the chief executive along with three directors of its three major wings such as Research Wing, Support Service Wing and Training & Communication Wing. The research Wing executes and monitors all the research programs and other research activities through 7 special crop research centers, 17 research divisions, 7 regional agricultural research stations and 30 sub-stations. Support Service Wing provides all the logistics support for research and personnel management. This wing is also responsible for infrastructural development and general procurement of the institute. The Training & Communication Wing is responsible for human resource development through conducting short term, mid tram as well as long term training and arranging scholarships for higher studies. Dissemination of information through print and electronic media, organizing seminars and symposia are also the important areas of activities of this wing.

BARI has a long historical background of its own. The emergence of the Institute in its present status has occurred through a number of changes starting from simply a sub-ordinate status under the Department of Land Records in the then Bengal. On the recommendation of the famine commission in 1880, the Bengal Department of Agriculture was established as a sub-ordinate part of the Department of Land Records in the then Bengal. In 1906, Lord Curzon, the then Vice Roy of India had granted separate status to the Bengal Department of Agriculture and in the same year, a Nuclear Agriculture Research Laboratory under this department was established at Tajgaon, Dhaka In 1908, an experimental station what has become known as Dhaka Farm was established on an area of 161.20 hectares of land. This Dhaka Farm was the predecessor of BARI and some other research institutes. Establishment of Dhaka Farm offered a good scope for conducting research in the field level in 1947, Bengal Department of Agriculture was renamed as East Pakistan Department of Agricultural. The two constituent divisions of the department were Research and Extension. In 1962, there was a severe blow to agriculture research when the land of Dhaka Farm was acquired for establishing Second Capital (today called Sher-e-Bangla Nagar). In 1968 two separate directorates were established – one was Directorate of Agriculture (Extension and Management) and the other was Directorate of Agriculture (Research and Education). The Directorate of Agriculture (Research and Education) was mostly concerned with research. This directorate was also responsible for the management of Bangladesh Agriculture Institute (BAI) at Sher-e-Bangla Nagar, Dhaka. Later in 1980s and 1990s, two other agriculture colleges, one in Patuakhali and the other in Dinajpur, were established. These two agriculture colleges were also administered by BARI until these became universities In 1971, the former provincial organization took on national responsibilities. Like many other sectors, agricultural sector inherited poor manpower and insufficient administrative set ups as well. Therefore, it was rightly thought to have established a coordinated and comprehensive research and some major decisions were taken up in 1973. Another important development in the year was the presidential Order No. XXXII that helps strengthen and reconstitute agricultural research organizations and system in the country. Upon subsequent developments of research institutions led to further restructuring In 1976, through the presidential Order No. LXII, the Bangladesh Agricultural Research Institute (BARI) emerged as an autonomous and effective research organization following the dissolution of the Directorate of Agriculture (Research and Education) with sufficient operational flexibility, structural modification and improvement of regional and sub-stations.

Organizational Information:



Operational information:

Director General who is the Chief Executive of the institute has overall responsibility for administration, finance, development and execution of program related to research, manpower development, dissemination of information, transfer of technology and other extension activities. The Director General is assisted by three directors: Director (Research), Director (Support Service), and Director (Training & Communication).

Director (Research) is responsible for program planning, monitoring and evaluation of the research activities as performed by the research centers, divisions and the regional and sub-stations.

Personal management, finance & accounts, procurement, infrastructure development, security, transportation and repair & maintenance are the major responsibilities of Director (Support Service)

Director (Training & Communication), on the other hand, is responsible for the transfer of technologies to the users through trainings, seminars, workshop, print & electronic media. Human resource development through training and arrangement scholarships for higher studies at home and aboard also fall within his responsibilities.

Each research division is headed by a Chief Scientific Officer (CSO) who is also designated as divisional head whereas a research center is headed by a Director/Project Director. Each divisional head is assisted by the concerned scientist starting from Scientific Officer (SO) to Principal Scientific Officer (PSO). On the other head, each research center is comprised of scientists from various disciplines in the rank of Scientific Officer (SO) to Chief Scientific Officer (CSO).

Regional Stations are headed by senior scientist equivalent to the status of CSO, while the sub-stations are headed by the scientists in the rank of either PSO or SSO.

Decisions and acts: Not Applicable

Public services information:

A. Citizen Charter

BARI has a well defined citizen charter. This citizen charter has been uploaded on the BARI website (www.bari.gov.bd).

B. Other services

- Provide farmers and other stakeholders with necessary information through publications and other associated forms end users in order to increase crop productivity and profitability.
- Provide different types of stakeholders with day to day activities and performances.
- Provide information and performance records to the concerned Ministry, policy makers, scientists, and other stakeholders for the realization of the institute's performances.
- Provide scientists, teachers, and other scholars for mutual self development through knowledge sharing.
- Provide visitors and other stakeholders with necessary information related to BARI as an organization.
- Provide farmers and other end users with information for awareness building.
- Disseminate information with regard to research, training, budget, etc. of the Institute.

Opening meetings information: Not Applicable

Decision-making & public participation: Not Applicable

Report on implementation of Development and Social Safety Net projects:

BARI has been implementing a number of development and social safety net projects. Lists of those projects have been uploaded on the BARI website (www.bari.gov.bd).

Subsidies information: Not Applicable

Public procurement information:

The public procurement of BARI is done through tender for works and goods. Lists of the tenders have been uploaded on the BARI website (www.bari.gov.bd).

Lists, registers, databases: Not Applicable

Information about information held: Not Applicable

Information on Publications:

Editorial & Publication Section is mandated to publish all kinds of publications such as reports, journal, newsletters, brochures, booklets, leaflets, folders, books and other manuals and literatures for dissemination of information and technologies to different clienteles.

Matters of public Interest: Not Applicable

Modes of proactive Disclosure presently used in BARI

- Website
- Annual Report
- Citizen Charter
- Newspaper Advertisement/Newsletter/leaflets etc
- Notice Board

Information on Right to Information: RTI of BARI

Designated Officer	
Officer's name	**:** Dr. Md. Saiful Islam ড. মো: সাইফুল ইসলাম
Designation	: Principle Scientific Officer (PSO)
Phone	: 9261506
Mobile	: 01552-388731
Email	: saiful@bari.gov.bd
Website	: www.bari.gov.bd
Office	: ASICT Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

Designated Officer (Alternative)	
Officer's name	: Md. Mizanur Rahman Khandaker মো: মিজানুর রহমান খন্দকার
Designation	: Deputy Director (Admin)
Phone	: 9264280
Mobile	: 01552-385116
Email	: mizanur73@yahoo.com
Website	: www.bari.gov.bd
Office	: Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

Designated Officer (Alternative)	
Officer's name	: Dr. Md. Rafiqul Islam Mondal ড. মো: রফিকুল ইসলাম মন্ডল
Designation	: Director General
Phone	: 9263540
Mobile	: 01714-179048
Email	: dg.bari@bari.gov.bd
Website	: www.bari.gov.bd
Office	: Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

List of Information delivery to the citizen during 2015

তথ্য অধিকার আইন, ২০০৯ এর ফরমেট অনুযায়ী তথ্য সরবরাহের জন্য প্রাপ্ত আবেদনের সংখ্যা	তথ্য সরবরাহের মাধ্যমে নিষ্পত্তিকৃত আবেদনের সংখ্যা	অনুরোধকৃত তথ্য না দেয়ার সিদ্ধান্তের সংখ্যা ও উক্ত সিদ্ধান্ত গ্রহণের কারণ	দায়িত্বপ্রাপ্ত কর্মকর্তার সিদ্ধান্তের বিরুদ্ধে আপীলের সংখ্যা	আপীল নিষ্পত্তির সংখ্যা	কর্তৃপক্ষ কর্তৃক দায়িত্বপ্রাপ্ত কর্মকর্তার বিরুদ্ধে গৃহীত শাস্তিমূলক ব্যবস্থার সংখ্যা	তথ্য অধিকার (তথ্য প্রাপ্তি সংক্রান্ত) বিধিমালা ২০০৯ এর বিধি ৮ অনুযায়ী তথ্যের মূল্য বাবদ আদায়কৃত অর্থের পরিমাণ	কর্তৃপক্ষ কর্তৃক গৃহীত বিভিন্ন কার্যক্রমের বিবরণ	মন্তব্য
১	২	৩	৪	৫	৬	৭	৮	৯
১৫২ *৩টি (তথ্য কমিশনের ফরমেট অনুযায়ী) *১৪৯টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই-কৃষি সংক্রান্ত তথ্যের প্রশ্ন সংখ্যা)	১৫২ *৩টি (তথ্য কমিশনকে জানানে হয়েছে) *১৪৯টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই- কৃষি সংক্রান্ত তথ্যের উত্তর সংখ্যা)	-	-	-	-	-	-	

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