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BARI Annual Report 2014-15

Bangladesh Agricultural Research Institute

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Bangladesh Agricultural Research Institute

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Foreword

This volume of annual report of the institute contains the important findings of the studies conducted during the year 2014-15. 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, rape, 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.

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 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. I sincerely congratulate and thank those who worked hard to prepare this report.

(**Dr. Md. Rafiqul Islam Mondal**)
Director General

Board of Management

Chairman

Director General (Ex-officio)

Member

- Two eminent scientists, one in social science and other in the field pertaining to the speciality of the Institute (nominated by the Ministry or the Division dealing with agriculture)
- A representative of the Council (nominated by the Council)
- The Directors of the Institute (Ex-officio)
- Two senior scientists of the Institute (nominated by the Ministry or the Division dealing with agriculture)
- A representative of the DAE not below the rank of Director (nominated by the Ministry)
- Two representatives, one from the Ministry or the Division dealing with agriculture and the other from the Finance Division not below the rank of Deputy Secretary (nominated by the respective Ministry or Division)
- Two representatives, one from among the farmers and the other from among the non-Govt. Organizations (NGOs) performing functions similar to those of the Institute (nominated by the Ministry or Division dealing with agriculture)

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

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 to enhance wheat productivity in Bangladesh. Development of heat tolerant variety has been given the highest research priority in the context of global climate change. Due emphasis has also been given to develop varieties with tolerance to 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, due emphasis has been given towards developing varieties for improved bread making quality. Efficient deployment of resistance genes into the genotypes with good agronomic background for 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, especially 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 that are utilized for target oriented hybridization. Segregating generations are advanced following selected bulk method. Every year hundreds of new lines are being added in the nurseries/trials for performance evaluation. Wheat research activities on variety development during 2014-2015 are described in this report.

Hybridization

The main objective of hybridization is to combine and recombine desired genes in the background of adapted genotypes for creating variability of good agronomic traits. This will be further followed up through selection and reselection of desirable plants in subsequent generations with a view to develop improved varieties.

A total of 524 single, 34 top and 82 backcrosses were made this year to incorporate the desired genes in the adapted genotypes. The hybridization programme has been conducted at five research stations: Dinajpur, Joydebpur, 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 from the selected F_1 population for growing F_2 generation in the next season. On the basis of phenotypic expression of hybrids with their respective female parents 401 F_1 populations were confirmed as hybrids. In addition, 61 top and 68 back crosses 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.

Selected bulk method was followed during selection in F_2 to F_6 segregating generations. Selections were based on good plant vigour, earliness, medium height, spike fertility disease resistance, etc. The F_2 families were thoroughly evaluated in the field and 401 families were selected out of 594. A total of 235 F_3 and 109 F_4 families were selected out of 354 and 174 families, respectively. A total of 73 F_5 families were selected from 82 families from where 874 individual plants were selected based on field performance and physical grain characteristics. Sixty five F_6 families out of 509 were selected for inclusion in Bangladesh Wheat Screening Nursery (BWSN) for the next season. The selected families, individual plants, and whole plots from different generations will be grown at different stations next year to select the promising ones for advancing the generations.

Bangladesh wheat screening nursery (BWSN)

Bangladesh Wheat Screening Nursery is an important nursery of wheat breeding programme of WRC. The selected genotypes from national and international nurseries/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 resistant, short stature, and early maturing suitable genotypes for inclusion in preliminary yield trial (PYT). There were two sets of BWSN.

In the BWSN-1, sixty genotypes including two check varieties Shatabdi and BARI Gom 26 were evaluated at the WRC, Dinajpur, Joydebpur, and Jessore under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions. There was significant difference in yield and other characters between two seeding dates. The genotypes showed significant variation for all the traits. Nineteen genotypes viz., E-4, E-5, E-6, E-7, E-11, E-12, E-13, E-14, E-15, E-16, E-17, E-19, E-27, E-30, E-38, E-40, E-50, E-54 and E-57 were selected for inclusion in PYT next year. Fifty six genotypes including two check varieties Shatabdi and BARI Gom 26 were evaluated in BWSN-2 at WRC, Dinajpur and Jessore under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions. There were significant differences in yield and other characters between two seeding dates. The genotypes also showed significant variation for all the traits under ITS and ILS conditions. Based on overall performances 6 genotypes viz., E-4, E-7, E-8, E-9, E-18 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 resistance to leaf rust diseases.

Preliminary yield trial (PYT)

The advanced lines selected from BWSN were tested for yield over locations in different growing conditions. The Preliminary Yield Trial was conducted to evaluate the performance of the advance lines compared to the existing check varieties and select the promising lines for inclusion in the Advanced Yield Trial (AYT) next year.

In 2014-15, there were two sets of PYT. In the PYT-1, 18 advanced lines along with check varieties Shatabdi and BARI Gom 26 were evaluated at WRC, Dinajpur, RWRC, Joydebpur and RARS, Jessore in RCB design with three replications under irrigated optimum, irrigated late and irrigated very late sown (IVLS) conditions. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, etc. The highest yield was recorded in Dinajpur in ITS condition and lowest in Jessore under IVLS (Irrigated Very Late Sown) condition. In both the sowing times, Dinajpur produced the highest 1000-grain weight (TGW) than other locations. The highest grain yield (5333 kg ha^{-1}) was obtained from Entry no. 7 in Dinajpur and all of the entries produced higher yield under timely sown condition compared to late sowing and very late sown conditions in both the locations Dinajpur and Jessore. The lowest grain yield (1816 kg ha^{-1}) was obtained from Entry no. 7 in Jessore under IVLS condition. Considering the overall performance, 11 genotypes viz., E-5, E-7, E-10, E-11, E-13, E-14, E-15, E-17, E-18, E-19 and E-20 were finally selected for testing in AYT next year. Eighteen advanced lines along with check varieties Shatabdi and BARI Gom 26 were evaluated in PYT-2 at WRC, Dinajpur and RARS, Jessore in factorial RCBD with three replications under irrigated optimum and irrigated late sown conditions. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, etc. The highest yield was recorded in Dinajpur in ITS condition and lowest in the same location in ILS condition. In both the sowing times, Dinajpur produced the highest TGW than other locations. The highest grain yield (5177 kg ha^{-1}) was obtained from Entry no. 3 in Dinajpur and Entry no. 17 yielded the lowest in the same location. In all locations Shatabdi matured later than other genotypes. Considering the overall performance, 6 genotypes Entry 6, Entry 8, Entry 10, Entry 13 Entry 14 and Entry 15 were finally selected for testing in AYT next year.

Advanced yield trial (AYT)

The selected outstanding genotypes from AYT were included in this trial for further evaluation across different agro-ecological conditions to confirm their 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 outstanding.lines for further evaluation in multi-location trials at farmers' fields.

Eight advance lines of wheat along with check varieties Shatabdi and BARI Gom 26 were including this trial was conducted at WRC, Dinajpur, Joydebpur, Jamalpur, Jessore, Ishurdi and Rajshahi. The trial was laid out in RCB design with three replications. The trial was planted under irrigated timely sown and irrigated late sown conditions. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, etc. The effect of sowing time, location and genotypes and their different interaction levels were significant for most of the traits. All the genotypes produced the higher TGW compared to both the check varieties. All the selected genotypes produced higher yield compared to both the checks. Considering the effect of locations across sowing times, the highest yield (4694 kg ha^{-1}) was obtained at Ishurdi and the lowest (3810 kg ha^{-1}) at Rajshahi. The selected lines showed lower yield losses due to late seeding compared to both the check varieties. Considering the overall yield and other characters the genotypes BAW 1208, BAW 1209, BAW 1219 and BAW 1222 were finally selected for further evaluation in Candidate Variety Demonstration (CVD) next year.

Early heat tolerant wheat screening nursery (2^{nd} EHTWSN)

Twenty four high yielding spring wheat genotypes including two check varieties Shatabdi and BARI Gom 26 were evaluated at Joydebpur, Rajshahi and Dinajpur under early sown condition during Rabi, 2014-15. 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 nine genotypes viz., E-3, E-4, E-7, E-11, E-12, E-13, E-22, E-23, and E-24 were finally selected for further evaluation.

Early maturing wheat screening nursery (2^{nd} EMWSN)

Sixteen early maturing spring wheat genotypes including two check varieties BARI Gom 28 and BARI Gom 30 were evaluated at Dinajpur and Jessore under optimum and late seeding conditions. The experiment was undertaken to study the effect of location and seeding time on early maturing genotypes for some phenological and physiological (canopy temperature) traits, disease resistance, yield and yield components. Significant variations were observed among the genotypes for most of the traits. The genotypes varied significantly for yield and other characters under different seeding times over location. As no significant advantage could be noticed among the genotypes for earliness none of them was selected for advancement. However, E-4, E-5, E-8 and E-12 will be tested further to verify their performance under different environmental conditions.

Drought wheat yield trial (2nd DWYT)

A total of 30 advanced lines were included in this nursery. The experiment was sown at RWRC, Rajshahi experimental field on 5 November, 2014. 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 visual grain quality eight genotypes viz., E-5, E-6, E-9, E-10, E-16, E-17, E-20, and E-24 were selected for further evaluation in the next season.

Screening of wheat genotypes for drought tolerance emphasizing coleoptile length

A field trial was conducted at WRC, Dinajpur to evaluate wheat germplasm for variability in coleoptile length and genotype performance under two different sowing depths with and without irrigation in the 2014-15 season. Emergence delayed (ED), leaf chlorophyll content, heading and maturity days, and harvest index (HI) increased, while area under curve for early ground cover (AUC-GC), plant height (PH) and biomass (BMS) decreased due to deep planting. Drought induced under non-irrigated condition, increased grains per spike and 1000-grain weight to support the ultimate grain yield in deep sowing condition. Coleoptile length (CL) measured at 18.5°C and under deep sowing condition (10cm) was higher than 28.0°C and normal condition (5cm). Significant correlation was observed for CL measured at 18.5°C with 28.0°C and deep sowing condition. Stepwise regression for 19 variables indicated that yield was mainly the product of ED, number of seedlings per plot, canopy temperature at grain filling, AUC-GC, area under curve for senescence development, wax, PH, number of spikes per plant, BMS and HI. Path analysis of selected variables in deep sowing condition indicated that BMS and HI had highest contribution to yield, both directly and indirectly with other variables under both irrigated and non-irrigated conditions. Among thirty genotypes, four have been selected for yield considering BMS and HI with long coleoptiles. The results suggested that the study of genotypic variation for sowing depth and CL could be useful for drought screening in wheat.

Zn-enrich wheat yield trial (ZnWYT)

Twenty-two zinc enrich wheat genotypes selected from 4th HPYT along with check varieties BARI Gom 25 and BARI Gom 26 were evaluated in the experimental field of RWRC, BARI, Gazipur and WRC, Nashipur, Dinajpur during Rabi 2014-15. Genotypes were tested for enriched micronutrient (Zn and Fe) concentration at CIMMYT, Mexico and selected for this study. The genotypes were grown under optimum condition with full irrigation. The experimental design was 6 x 4 alpha lattice with 2 replications. Significant variation was observed for most of the traits studied. Only the genotype E-11 out yielded (4789 kgha^{-1}) all the genotypes and check varieties BARI Gom 25 (4323 kg ha^{-1}) and BARI Gom 26 (4724 kg ha^{-1}). Another genotype E-4 out-yielded (4524 kg ha^{-1}) the check variety BARI Gom 25 only. Zn concentration ranged from 42 to 63 ppm. Considering earliness, good agronomic traits, seed quality, yield potential and Zn content, 7 genotypes E-4, E-11, E-15, E-16, E-19, E-20 and E-23 have been selected for further evaluation. The selected Zn-enriched lines will be promoted to yield trial across location.

Production of wheat double haploids through wheat x maize crossing

Wheat is the most widely grown and consumed food crop in the world. Intensive breeding in modern times has led to the adaption of wheat to a wide range of ecological conditions (temperate, subtropical, and tropical). Conventional recombination breeding is not only time consuming but subjected to selection errors. An erroneous selection based on phenotype in the early generation will thus affect the whole breeding effort. Therefore, any method which offers infinite F_2 population in homozygous state would cut short breeding time and help in increasing selection efficiency of breeding programmes.

Cytogenetic findings have now presented the double haploid (DH) technique to facilitate the creation of new genetic variability in the form of a multitude of homozygous true breeding lines. Selection during the early generations of pedigree programme if compared with that of double haploids (DH), homozygosity obtained from using a DH system increases efficiency of selection both for qualitative and quantitative characteristics. It is thus easier to identify superior genotypes using a DH system because the frequency of fixation in an F_1 derived DH population is the square root of the probability in an F_2 population.

In order to produce double haploid lines, two F_1 hybrids of bread wheat were crossed with maize pollen. Out of 421 pollinated florets from two F_1 hybrids of wheat, 340 green parthenocarpic caryopsis (GPC's) were developed which was 80.76% of total pollinated florets. A total of 70 embryos (20.59% of GPC's) were rescued and 35 of them (50% of total embryos) germinated. Ten haploid (14.29% of total embryos) green plants regenerated from the germinated embryos. Regenerated haploid plants were treated with colchicine and diploid plants were obtained. Eight plants were survived out of 9 colchicine treated haploid plants. Colchicine treatment resulted diploidization and ninety percent of total plants survived. The results demonstrated the effectiveness of the method to produce homozygous wheat genotypes in short time by doubling of haploid lines generated through pollination of wheat F_1 plants with maize pollens.

Collaborative studies with international organizations

Wheat Research Centre, BARI has been conducting research in collaboration with International Maize and Wheat Improvement Centre (CIMMYT), Mexico and its different projects like Cereal System Initiative in South Asia (CSISA) objective 4. CIMMYT has the strategy to test their advanced genotypes in different mega-environments throughout the world. This provides us opportunity to select exotic genotypes adapted to our environmental conditions and CIMMYT also gets the data of the performance of their genotypes over locations.

Seven international bread wheat nurseries and trials were conducted at different research stations of the Wheat Research Centre, BARI during 2014-15. 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 60 genotypes out of 726 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 (35th ESWYT)

Forty nine elite wheat genotypes selected for mega-environment five along with one check variety BARI Gom 26 were included in this trial. The trial was conducted at the Wheat Research Centre (WRC), Dinajpur following alpha-lattice design with 2 replications. The genotypes were evaluated for yield, heading, maturity, plant height, number of grins per spike, 1000 grain weight, Bipolaris leaf blight, spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. On the basis of overall performance entry 118, 123 and 124 were selected for further evaluation in Bangladesh wheat screening nursery next year.

International bread wheat screening nursery (47th IBWSN)

Three hundred four elite wheat genotypes selected for mega-environment five were included in this nursery. The genotypes were evaluated at the Wheat Research Centre (WRC), Dinajpur in non-replicated trial. Widely used 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 (E-1030, E-1053, E-1071, E-1222 & E-1245) were selected for further evaluation in heat tolerant wheat yield trial next year.

Thirteenth high temperature wheat yield trial (13th HTWYT)

Forty nine genotypes selected by CIMMYT, Mexico for high temperature, irrigated environments were evaluated in a trial at WRC, Dinajpur and RARS, Jessor under late seeding condition. WRC recommended management was followed to raise the crop. The genotypes were evaluated for yield, heading, plant height, Bipolaris leaf blight and spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. Considering overall performances, five genotypes (E-12, E-19, E-42, E-44 & E-45)were selected for further evaluation in heat tolerant wheat yield trial next year.

Semi-arid wheat yield trial (22nd SAWYT)

The trial was consisted of 50 advanced, high yield potential wheat lines provided by CIMMYT, Mexico including one check variety BARI Gom 26. The trial was conducted at RWRC, Rajshahi during Rabi 2014-15 to evaluate the yield potentiality of the genotypes 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, spike fertility, visual grain quality, boldness of grains etc. On the basis visual grain performance and others yield contribution characters the eight genotypes (E-3, E-5, E-18, E-21, E-22, E-32, and E-40) were selected among the genotypes.

Semi-arid wheat screening nursery (32nd SAWSN)

Semi-Arid Wheat Screening Nursery has been designed for relatively warmer and low rainfall environments. So, this nursery was tested in drought prone regional station, Rajshahi to evaluate some CIMMYT advanced lines and to select the promising ones for that area.

One hundred and ninety six elite genotypes received from CIMMYT, Mexico were evaluated against the check variety BARI Gom 26 in RWRC Rajshahi during Rabi 2014-15. 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 fourteen genotypes (E-1, E-6, E-19, E-28, E-61, E-66, E-127, E-, E-132, E-138, E-145, E-158, E-171, E-177 and E-206) were selected from RWRC, Rajshahi for further evaluation

Stress adaptive trait yield nursery (4th SATYN)

Abiotic stresses were the major yield limiting factors for wheat under changing climatic condition. So, emphasis has given to develop stress tolerant varieties to enhance wheat productivity. Some physiological traits along with yield potentiality contribute to stress tolerance. Therefore, this nursery was tested in different locations of Bangladesh to identity potential stress adaptive traits under irrigated late sown condition and to select promising genotypes suitable for this environment.

The nursery was consisted of 28 elite genotypes of wheat. It was grown under irrigated late sowing condition. Considering different morpho-physiological characters, yield contributing characters and yield performance eight genotypes viz., Entry-1, Entry-2, Entry-5, Entry-9, Entry-11, Entry-13, Entry-18 and Entry-26 were selected for further evaluation.

Harvest plus yield trial (5th HPYT)

Fifty zinc-enriched wheat genotypes from CIMMYT including check variety BARI Gom 26 were evaluated at Joydebpur and Dinajpur during 2014-15. Genotypes were tested for Zn concentration, different physiological traits related to heat tolerance and high yield potential under irrigated timely seeding (ITS) condition. The experimental design was 5 x 10 alpha lattice with 2 replications. Significant variation was observed for most of the traits studied. Out of 49 genotypes tested, 30 entries gave higher grain yield than the check variety over location. Considering different phenological and physiological traits, seed quality, Zn content and yield potential 17 genotypes E -2, E-4, E-5, E-7, E-8, E-9, E-10, E-11, E-12, E-17, E-9, E-23, E-24, E-31, E-40, E-43 and E-46 have been selected for further evaluation.

PVS mother and baby trials and informal seed dissemination

Participatory research was conducted at the farmers' fields of Dinajpur, Rajshahi, Jessore, Patuakhali, 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, focus group discussion, evaluation workshops, trainings and frequent interactions. Farmers' overall score at physiological maturity stage was the highest for BAW 1177 (score 8.4) followed by BARI Gom 25 (score 8.1). Farmers' chose BAW 1170 for its short stature (score 8.8) and early maturity (score 8.7). Whereas, the highest overall score after harvest was recorded for BARI Gom 25 due to its bold shinny grains with higher yield (score 8.5) followed by BAW 1182 (score 8.3). Whereas, the highest mean grain yield was recorded in BARI Gom 26 (3453 kg ha^{-1}) followed by BAW 1170 (3441 kg ha^{-1}). Overall, BARI Gom 25 and BAW 1182 were the highest preferred genotypes over locations. Unfortunately, the lowest mean yield was recorded in BAW 1177 (3089 kg ha^{-1}). In baby trials, BAW 1182 and BAW 1177 produced higher mean yields than the check variety BARI Gom 25. The line BAW 1182 produced the highest yields in all locations.

Durum yield trial (DYT)

Durum (*Triticum durum*) is a non-traditional minor cereal crop in Bangladesh. Durum wheat or macaroni wheat is the only tetraploid species of wheat of commercial importance that is widely cultivated. It was developed by artificial selection of the domesticated emmer wheat strains formerly grown in Central Europe and Near East around 7000 B.C. Durum in Latin means "hard", and the species is the hardest of all wheat. Its high protein and gluten content, as well as its strength, make durum good for special uses. Durum grain is highly suitable for quality bakery products like macaroni, noodles etc. Arab cuisine it forms the basis of many soups, gruels, stuffings, puddings and pastries. Coarsely ground durum used for making pasta is known as "semolina". When ground as fine as flour, it is used for making bread. In the Middle East it is used for flat round breads, and in Europe and elsewhere it can be used for pizza, torte etc. It is not, however, good for cakes, which are made from soft wheat to prevent toughness. In the American Great Plains, durum wheat is used almost exclusively for making pasta products such as spaghetti and macaroni. Durum wheat has strong gluten content although its life span is relatively longer as compared to bread wheat. Due to its strong gluten content and other bread making quality it extensively used for commercial production of noodles, pasta, spagati and macaroni. In Bangladesh consumption of these food products are increasing day by day. There are some food industries in Bangladesh which are producing these food items by importing durum wheat from abroad. There is a good potentiality to grow durum wheat in cooler-dry northern parts of Bangladesh which can be eventually used in producing these food items.

Twenty-seven durum lines along with BDW 8 as check were evaluated at Wheat Research Centre, Dinajpur in rabi 2014- 15. Significant variations were observed among the entries for days to heading, days to maturity, plant height, spikes /m^2, grains/spike, thousand grain weight and yield. Most of the test entries yielded more than the check BDW 8. The highest grain yield was obtained from the entry E- 4 (4721 kg/ha) followed by E- 12 (4543 kg/ha). Thousand grain-weights of most of the durum entries were more than that of BDW 8. The 1000-grain weight of the entry E- 28 was the highest (42.58 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 eight promising durum entries viz., E- 4, E- 11, E-12, E- 15, E-20, E- 24, E-25 and E- 28 were selected for further study.

Adaptive trial with advanced durum lines

Five advance durum lines along with three checks were evaluated at WRC, Dinajpur and RARS, Ishurdi during rabi 2014-15. The yield and yield contributing traits were differed significantly among the entries. The highest yield (4109 kg/ha) was obtained from BDW 53 and the lowest yield (2613 kg/ha) from Morocco 1. The maximum (48.0 g) thousand-grain weight was recorded in BDW 53 and the lowest (36.6 g) TGW was recorded in Morocco 1. The earliest (110 days) maturing genotype was BDW 60. On the basis of field performance, disease reaction, grain physical characteristics and yield, only two promising durum entries viz. BDW 53 and BDW 68 were selected for further study.

International durum yield nursery (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.

Forty nine durum entries from CIMMYT along with BDW 8 as local check were evaluated at WRC, Nashipur, Dinajpur, during Rabi 2014-15. Performance of some durum line were satisfactory compared to check BDW. The highest yield (5573 kg/ha) was obtained from E-721. The maximum (45.70 g) thousand grain weight (TGW) was recorded in E-713. On the basis of field performance, disease reaction, grain physical characteristics, and yield, only seven durum lines viz., entry E-706, E-710, E-713, E-717, E-721, E-734 and E-749 were selected for further evaluation over environments

Triticale yield trial (TYT)

Triticale (X *Triticosecale*) is a hybrid of durum wheat (*Triticum durum*) and rye (*Secale cereale*) first bred in laboratories during the late 19th century. Triticale combines the high yield potential and good grain quality of wheat with the disease and environmental tolerance of rye. It is a useful dual-purpose crop for grain and forage biomass. It is grown mostly for forage or animal feed although some triticale-based foods can be purchased at food stores or are to be found in some breakfast cereals. According to FAO, 13.5 million tons triticale was harvested in 28 countries across the world in 2005. CIMMYT has released high yielding spring triticale lines (e.g. Pollmer-2) which have surpassed the 10.0 t/ha yield barrier under optimum production conditions. Triticale has potential in the production of bread and other food products such as pasta and breakfast cereals. The protein content is higher than that of wheat although the glutenin fraction is less. Triticale is a better ruminant feed than other cereals due to its high starch digestibility. As a feed grain triticale is already well established and of high economic importance. It has received attention as a potential energy crop and research is currently being conducted on the use of the crops biomass in bioethanol production. In Bangladesh, it is a non-traditional cereal that grows well during the cool and dry rabi season (November-March) when small-scale dairy farmers face a severe shortage of quality fodder. November to February is the lean period for most popular fodder grasses like Napier and Para. The green grass from triticale as well as the grains of triticale was found highly nutritious for cattle and triticale grains could be an alternative to wheat and maize with cheaper price especially for poultry enterprises. Thus dual-purpose triticale was identified as an exciting new option for forage and grain production.

Variety maintenance and breeder seed production

Upon release of a new variety, a breeder use to keep a small quantity of seed stock that is very pure and represents the variety. This stock is referred to as parental material and forms the basis of any future maintenance and seed multiplication of the variety. Maintenance is defined as “the perpetuation of a small stock of parental material through repeated multiplication following a precise procedure”.

Wheat Research Center's maintenance breeding program is always trying extremely to maintain the purity of varieties and cultivars. A seed program capable of providing farmers with good quality seed is essential to a nation's agricultural development and seed is not just something planted by the farmers or companies, it is the carrier of the genetic potential for higher crop production. Pure line theory still one of the best conception for maintaining varietals purity of cereal crops. Wheat Research Center's maintenance breeding program had also been developed on the basis of the conception of pure line theory. Therefore, the objective of this program was 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 2014-15, four bread wheat varieties namely BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 were maintained in first year line and second year line at WRC, Dinajpur. From the second year lines, a total quantity of 2050 kg seed from the selected plots of four varieties were produced for utilizing in breeder seed production of around 20 ha next year.

Cultural Practices

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

A long term bed planting experiment was conducted at RWRC, Shyampur, Rajshahi to study the productivity, soil fertility and N-use efficiency of intensified rice-wheat (R-W) cropping system by adding a third pre-rice crop of 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 (100 kg/ha)), two straw retention (SR) (0 and 30%) and two tillage options *viz.*, permanent raised bed (PRB) and conventional tillage practice (CTP).

Results indicated that rate of N fertilizer can be reduced when 30% straw was retained both from rice and wheat and full residue retention from mungbean. Soil organic matter in surface soil layers of the PRB had increased by 0.78% after twelve years (12 wheat-mungbean-rice 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 R-W systems in Bangladesh.

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

An experiment was conducted at RWRC, Shyampur, Rajshahi to study the productivity and soil fertility of intensified rice-wheat cropping system by adding a third pre-rice crop of maize. 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) 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 compare to conventional practice of well-till without crop residue retention. Fresh bed with 30% straw retention showed the highest productivity and similar result were also obtained from permanent beds with 30% straw retention over conventional practice.

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

The experiment was conducted in RARS, Jessore to know the suitability of intercropping mustard with wheat in bed planting system under rice-wheat system. Grain yield and yield contributing characters of wheat was significantly influenced by the treatments except days to heading and maturity as mustard was intercropped under bed planting system. The highest grain yield of wheat was obtained from sole wheat treatment followed by one row mustard (30×10 cm) in between two beds of wheat (20×5 cm) due to intercrop effect within the two crops. The lowest grain yield of wheat was obtained from the treatment two rows mustard in between two beds of wheat. The highest seed yield of mustard was obtained from sole mustard treatment followed by two rows mustard in between two beds of wheat. The highest wheat equivalent yield and gross return were obtained from two rows mustard in between to beds of wheat. The maximum BCR was obtained (3.0) from two rows of mustard in between two beds of wheat followed by one row mustard in between two beds of wheat.

Relay cropping of wheat with T. aman under Rice-Wheat system

This experiment was conducted in RARS, Jessore to ensure timely sowing of wheat and increasing productivity through relay cropping of wheat with T.aman under Rice-Wheat system. Significant differences were observed among the varieties in relay condition. Maximum heading days (66 days) was recorded from Shatabdi and minimum from BARI Gom 25 and BARI Gom 26. The highest maturity days was recorded also from Shatabdi (112 days). Maximum spikes m^{-2} was recorded from the variety BARI Gom 27 followed by Shatabdi and BARI Gom 28. The highest grain yield (3,483 kg ha^{-1}) was recorded from BARI Gom 28 in relay condition followed by BARI Gom 25 (3,300 kg ha^{-1}).

Effect of sowing depth on stand establishment and yield of wheat

The experiment was carried out at ARS, Rajbari, Dinajpur in two consecutive years to know the effect of sowing depth on emergence, tillering ability and yield of wheat. The treatments were four sowing depth *viz.*, 2, 4, 6 and 8 cm. Seed sowing at 4 cm depth resulted in the highest seedling emergence, while the lowest was recorded at 2 and 8 cm depth. The highest spikes m^{-2} was recorded in 4 cm depth and the lowest in 2 and 8 cm depth. The highest grain yield was recorded in 4 cm depth in both the years and the lowest in 2 and 8 cm depth. The straw yield also followed the similar trend.

On-farm evaluation of wheat varieties under limited irrigation in AEZ 22

An on-farm trial was conducted in split-plot design with 4 dispersed replications in Sherpur district (under AEZ 22) during rabi 2014-15 season to see the performance of 4 wheat varieties in the non-irrigated fallow lands of the area. Irrigation at CRI stage (I_1) produced significantly higher grain yield than non-irrigated/rainfed condition (I_0). This was attributed by the higher yield contributing characters. Non-irrigated (rainfed) wheat also produced a substantial yield (2,463 kg ha^{-1}). The maximum spikes m^{-2} (279) was observed in BARI Gom 26 with I_1 treatment followed by BARI Gom 27 with I_0 treatment, and the minimum spikes m^{-2} (245) was observed in BARI Gom 25 with I_0 treatment followed by BARI Gom 28 with I_0 treatment. The highest 1,000-grain weight (TGW) (45.9 g) was recorded in BARI Gom 28 with I_1 treatment and the lowest TGW (30.4 g) was recorded in BARI Gom 27 with I_0 treatment. The highest grain yield (3,125 kg ha^{-1}) was recorded in BARI Gom 26 with I_1 treatment followed by BARI Gom 26 with same treatment and the lowest grain yield (2,331 kg ha^{-1}) was recorded in BARI Gom 27 with I_0 treatment followed by BARI Gom 26 with same treatment.

Screening of wheat genotypes for deficit water

The experiment was conducted in the research field of WRC, Dinapur for identifying wheat genotypes which are able to produce considerable yield under water deficit condition. In first year, treatments were 30 selected wheat genotypes with three water regimes, were arranged in split plot design with three replications, where three water regimes {i.e., fully water deficit condition (no irrigation up to harvest), one irrigation (only applied at CRI stage) and control (three irrigation- one at CRI stage, second at booting stage and third at grain filling stage)} were arranged under main plots and 30 genotypes in sub-plots. Considering less grain yield reduction in water deficit conditions (no irrigation and one irrigation) as compared with control (three irrigations), 6 genotypes i.e., BARI Gom 25, BARI Gom 26, BAW 1118, BAW 1130, E-18 and E-38 were selected for second year (2014-15) study to confirm this result. In the second year, these 6 genotypes were evaluated in two water regimes (no irrigation, three irrigations), where two water regimes {i.e., 1. fully water deficit condition (no irrigation up to harvest) and 2. control (three irrigation- one at CRI stage, second at booting stage and third at grain filling stage)} were arranged under main plots and 6 genotypes (BARI Gom 25, BARI Gom 26, BAW 1118, BAW 1130, E-18 and E-38) in sub-plots. Considering on yield performance and the reduction of grained yield in water deficit condition as compared with three irrigation, two years result revealed that BAW 1118 was the best performing genotype, followed by E-38. BARI Gom 25 and BAW 1130 was the susceptible genotypes in water deficit condition.

Growth and yield of recently released wheat varieties/genotypes under raised bed system

The experiment was conducted at RWRC, BARI, Rajshahi. The main objectives of this study were to select suitable varieties under bed planting method for biotic and abiotic stress encountered in wheat based cropping system in Bangladesh. Recently released six varieties were evaluated under raised bed system in randomized complete block design with three replications. The varieties were evaluated for yield, and yield components with some phenological and physiological parameters. The effects of raised bed system over two years were significant for all the parameters. The highest mean yield over tillage method (among the tested genotypes) was produced by varieties BARI Gom 27and Shatabdi followed by BARI Gom 26 and Bijoy varieties. These genotypes produced satisfactory yields in raised bed methods. The lowest yielder varieties were Prodip and BARI Gom 25. Considering the overall growth parameters, yield and other characters 3 varieties BARI Gom 27, 26 and Bijoy have been provisionally selected at RWRC, Rajshahi for conclusive evaluation next year under raised bed system.

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

The trial was carried out in the Rabi season of 2014-15 in research field of Regional Wheat Research Centre, Rajshahi. Three varieties (BARI Gom 26, BARI Gom 27 and BARI Gom 28) and one advanced genotype (BAW 1151) of wheat were used in this trial. One irrigated timely sowing (ITS) and three irrigated late sowings (ILS) were evaluated. 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 in all genotypes including the yield and TGW 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 1151, 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 by about by 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 1151 in compared to irrigated timely sowing condition (ITS) for each 1°C rise in average mean air temperature during booting to maturity. However, reduction percent was 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 1151. Input variables of agro-climate (HDDS, RH, SSH, PR) and crop factors are calculated and summarized for modeling.

Screening of wheat genotypes against rainfed condition

Screening of wheat genotypes against drought stress (rainfed condition) experiment was conducted at five locations (WRC, Dinajpur, RWRC, Rajshahi, RARS, Jamalpur, RARS, Jessore and RWRC, Gazipur during November 2014 to March 2015. Eight wheat genotypes were evaluated against drought stress (without irrigation i.e. rainfed condition) compared to irrigated condition (i.e. control condition). Three quantitative drought tolerance indices like yield stability index (YSI), stress susceptibility index (SSI) and stress tolerance index (STI) were used to evaluate drought responses of these genotypes. In drought condition, Genotypes 23, BARI Gom 26 (check variety), 30, 31, 33 and 40 were selected on the basis of stress tolerance index (STI>1.00 or close to 1.00) measured based on grain yield in both drought and irrigated condition. Genotypes 9, 23, BARI Gom 26 (check), 30, 31 were selected on the basis of yield stability index (YSI > 75 %). Similar trend was observed on the basis of stress susceptibility index (SSI < 1.00) for grain yield. On the basis of stress tolerance indices, it may be suggested that those genotypes which were selected by STI might be cultivated in drought prone areas. On the other hand, genotypes which were selected through YSI and SSI could be used for conventional and molecular breeding as well as biotechnological aspect to incorporate drought tolerance mechanisms through introducing specific identified gene into high yielding genotypes for developing both high yielding as well as drought tolerant varieties. Considering the determination of Ascorbate peroxidase (APX), Catalase (CAT) and Proline, all genotypes might have drought tolerance to some extent. In case of Chlorophyll *b* (Chl *b*) genotypes 9, 21, and 40 and in respect of Carotinoid (Car) genotypes 23, 30 and 33, were selected for drought condition.

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. An 18 years study with rice and wheat cropping pattern was conducted on a sandy loam soil at Wheat Research Centre, Dinajpur to investigate the direct and residual effect of organic manures 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. However, a yield-declining trend was observed in the control. 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. Organic manure application in dry land winter crops like wheat performed better than organic manure application in wetland summer crop like rice. 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 8,830 kg ha^{-1} year^{-1} recorded in PM as both crops and followed by 8,803 kg ha^{-1} year^{-1} 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 aresult 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 soil properties and crop yield in wheat-rice cropping pattern

Crop residues especially wheat and rice straw removal from the field is more common in Bangladesh as multitude uses of straws, i. e. fuel for cooking, cattle feed, roofing material. The removal of crop residues leads to decline soil fertility and decreased crop yields. Main source of organic matter in Bangladesh is cowdung becoming unavailable because of reducing number of cattle gradually. Farmers are reluctant to practice green manuring in Bangladesh. However, farmers have to grow crops for their food and crop residues are undoubtedly unlimited and sustainable source of huge plant nutrients and soil organic matter if they keep it in their fields. The impact of crop residues in wheat-rice system or on soil fertility has rarely been documented in Bangladesh context. The present investigation was undertaken to observe the performance of crop residues to sustain soil fertility and productivity in wheat-rice cropping pattern since the year 2003-2004 at Wheat Research Centre, Dinajpur. The experiment consisted of 7 treatments was laid out in a randomized complete block design with 4 replications. The treatments were: 1) Residues removed from the plots, 2) 1/2 residues of both crops remained in the plots, 3) 1/3 residues of both crops remained in the plots, 4) 1/2 residues of wheat remained in the plots, 5) 1/3 residues of wheat remained in the plots, 6) 1/2 residues of rice remained in the plots, 7) 1/3 residues of rice remained 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 to residues addition. 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.

Water requirement of wheat under different tillage options

Underground water should be used judicially to grow any crop to sustain or improve underground water level. An experiment was conducted at the farm of Wheat Research Centre (WRC), Dinajpur having sandy loam soil to quantify irrigation water for cultivating wheat with different tillage options in 2014-15. The experiment was laid out in a split-plot design with 3 replications. The tillage options, i) Conventional, ii) Bed planting (BP) and iii) PTOS (Power tiller operated seeder) were assigned in main plots and the irrigation number, i) One, ii) Two and iii) Three irrigations were placed in sub-plots. Seed @120 kg ha^{-1} of the wheat variety, BARI Gom 28 was sown in row on 6 December 2014 by hand, bed planter and power tiller operated seeder (PTOS) in conventional, BP and PTOS plots, respectively. The distance between to rows in conventional and PTOS plots was 20cm. Incase of BP plots, the distance between to beds was 50cm and on surface of bed there were 2 rows of wheat. The height of the bed was 15cm. The soil moisture was measured initially (on the day of sowing) and on the day of each irrigation following gravimetric method of the surface soil (0-15cm). Plastic pipe was used for irrigating the lands and quantity of the water was measured using water flow meter. The outlet of the plastic pipe was fixed in one spot to irrigate bed planting plots. However, the outlet was moved and set in two or three spots of a plot during irrigate conventional or PTOS planted plots. The first, 2nd and 3rd irrigations were applied on 24 December 2014 (18 DAS), 03 February 2015 (58 DAS) and 26 February 2015 (81 DAS), respectively. The conventional and PTOS planted plots were irrigated up to create flooded condition to plots with water, while bed planting plots were irrigated to fill up the each furrow with water and reach the water level upto ridge of the bed. Water requirement to produce unit yield of wheat was calculated using formula: water requirement (Litre kg^{-1} grain)= water requirement (litre ha^{-1})/yield (kg ha^{-1}). Agronomical data along with quantity of the irrigation water were taken and statistically analyzed with MSTAT following F-test and the mean comparisons were made by DMRT at 0.05% level.

Quantity of irrigation water was not responded significantly by the main effect of tillage options and by the interaction effect of tillage options and irrigation levels. However, it was influenced by the main effect of irrigation levels. Obviously, the highest quantity of irrigation water was recorded with three irrigations and that was 1050 m^3 ha^{-1} and the lowest was 406 m^3 ha^{-1}in one irrigation. Although interaction effect of tillage options and irrigation levels and main effect of tillage options could not influence on quantity of irrigation water, the quantity of irrigation water was recorded maximum (773 m^3 ha^{-1}) in PTOS plots, minimum (694 m^3 ha^{-1}) in conventional plots and in between (752 m^3 ha^{-1}) in bed planting plots. Considering interaction effect, quantity of irrigation water was 358, 416 and 444 m^3 ha^{-1} for 1 irrigation; 712, 793, and 784 m^3 ha^{-1} for 2 irrigations and 1011, 1048 and 1090 m^3 ha^{-1} for 3 irrigations to irrigate plots of conventional, bed planting and PTOS tillage options respectively. Results indicating PTOS plots had required higher quantity of water compared to conventional. Possibly due to less compact, loose and floppy soils in PTOS plots created in time of sowing seed compared to conventional that little bit restricted run off of the water in PTOS plots than conventional. Although not significant lower quantity of irrigation water was required in conventional compared to bed might be due to movement of out let of plastic pipe with keeping two or three spots to irrigate conventional plots (42 m^2) rather than fixed in one spot. That could create opportunity for quick irrigation in the conventional plots. That practice also has been practiced by the farmers of northern Bangladesh to irrigate wheat fields.

Initial, before 1st and 2nd irrigations percent soil moisture was insignificant by the main effect of irrigation levels and tillage options and by their interaction. However, the mean %soil moisture was recorded 20.2, 13 and 11 as initial, before 1st and 2nd irrigations, respectively

Plant height, spikes m^{-2}, grains spike^{-1}, 1000-grain weight, grain and straw yields were significantly responded by the main effect of irrigation levels. However, neither yield nor yield components were significantly responded by the main effect of tillage options and by the interaction effect of tillage options and irrigation levels. The grain yield was increased with the increasing level of irrigation and the highest grain yield (4763 kg ha^{-1}) was recorded with three irrigations. Higher spikes m^{-2}, grains spike^{-1} and 1000-grain weight (TGW) were found in three irrigation plots those components contributed to produce higher yield in three irrigations. The highest straw yield was also found in three irrigation treatment.

The water requirement was 90, 102 and 114 litre kg^{-1} grain for 1 irrigation, 156, 178 and 176 litre kg^{-1} grain for 2 irrigations and 213, 221 and 226 litre kg^{-1} grain for 3 irrigations to irrigate lands of wheat planted by conventional, bed planting and PTOS tillage options, respectively.

Effect of bio-slurry in wheat-mungbean-T.aman cropping pattern

In Bangladesh most of the soils have less than 1.5% and some soils even less than 1% organic matter, but good soil should have at least 2.5% organic matter. Organic matter status is poor in most soils of

Bangladesh except in some pockets of forest and basins. Hence, improvement and maintenance of a good supply of organic matter through recycling in soils is a pre- condition for efficient cycling of nutrients. A long-term experiment has been initiated at Wheat Research Centre, Dinajpur in 2010-11 wheat growing season to evaluate the performance of bio-slurry in combination with chemical fertilizers in Wheat-Mungbean-T. aman cropping pattern. The experiment was laid-out in a randomized complete block design with 9 treatments. The treatments were T_1 (control), T_2 (100% recommended chemical fertilizer), T_3 (75% recommended chemical fertilizer), T_4 (75% of RCF + 5.0 t ha^{-1} bio-slurry), T_5 (75% of RCF + 7.5 t ha^{-1} bio-slurry), T_6 (75% of RCF + 10.0 t ha^{-1} bio-slurry), T_7 (75% of RCF + 5.0 t ha^{-1} bio-slurry in rice), T_8 (75% of RCF + 7.5 t ha^{-1} bio-slurry in rice) and T_9 (75% of RCF + 10.0 t ha^{-1} bio-slurry in rice).

The results of first two years studies indicated that addition of bio-slurry 5-10 t ha^{-1} in combination of 75% chemical fertilizers could not produce yield advantage of the crops than 100% RCF and 3rd year results indicated that addition of bio-slurry 10 t ha^{-1} in combination of 75% chemical fertilizers produced higher yield of wheat and mungbean than 75% RCF and similar to100% RCF. However, rice yield was higher with T_9 (75% of RCF + 10 t ha^{-1} bio-slurry in rice) than 100% RCF. Forth year results indicated that addition of bio-slurry 10 t ha^{-1} in combination of 75% chemical fertilizers produced significantly higher yield of wheat, mungbean and T.Aman than 100% RCF. The results indicating that bio-slurry had the positive impact on crops yield.

Effect of different doses of vermicompost in combination with chemical fertilizers in a potato-wheat-mungbean-T.aman cropping pattern

According to a conservative estimation, around 600 to 700 million tons (mt) of agricultural waste (including 272 million tons of crop residues) are available in Bangladesh every year, but most of it remains unutilized. This huge quantity of wastes can be converted into nutrient-rich vermicompost for sustainable land restoration practices. The earthworm-processed organic wastes, often referred to as vermicomposts, are finely divided peat-like materials with high porosity, aeration, drainage, and water holding capacity. The studies have revealed that vermicompost may have potentials as a source of nutrients for field crops if applied in suitable ratios with synthetic fertilizers. Therefore, A long-term experiment has been initiated at Wheat Research Centre, Nashipur, Dinajpur in 2012-13 to know the impact of different doses of vermicompost in combination with chemical fertilizers in a Potato-Wheat-Mungbean-T.Aman cropping pattern. The experiment was placed in randomized complete block design with 3 replications. There were 7 treatments, T_1 (absolute control), T_2 (100% recommended chemical fertilizer), T_3 (75% recommended chemical fertilizer), T_4 (75% RCF + 2.5 t ha^{-1}vermicompost),T_5 (75% RCF + 5 t ha^{-1}vermicompost), T_6 (100% RCF + 2.5 t ha^{-1}vermicompost) and T_7 (100% RCF + 5 t ha^{-1}vermicompost).

The yield and yield contributing characters of potato, wheat, mungbean and T.aman were significantly influenced by the treatments. The highest yield of potato (20.2 t ha^{-1} in 2012, 18.73 t ha^{-1} in 2013 and 14.95 t ha^{-1}in 2014) was found in T_7(100% RCF + 5 t ha^{-1}vermicompos) that was significantly higher than all other treatments. The highest wheat (5640 kg ha^{-1} in 2013-14 and 5365 kg ha^{-1} in 2014-15), mungbean (1398 kg ha^{-1} in 2013 and 1106 kg ha^{-1}in 2014), and T.aman (5550 kg ha^{-1}in 2013 and 4641 kg ha^{-1}in 2014) yields were obtained in T_7 (100% RCF + 5 t ha^{-1}vermicompost) and that were significantly higher than all other treatments.

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

Recently, integrated plant nutrient system (IPNS) based fertilization is advised to maximize productivity keeping the balance of soil fertility. The use of crop residue as mulch improves resource utilization and thereby contributed to productivity both under the tropical and semitropical environment. Mulch also contributed to carry over of residual soil moisture from one crop to another and thereby improved yield of rain fed wheat. Bed planting is also reported as efficient in resource utilization by wheat and maize crops. The soil test based fertilizer with organics (STB + 5 t/ha CD) was superior in producing higher yield in maize-mungbean-T. aman cropping pattern is also reported. Considering all these facts, an integrated approach of soil and nutrient management is essential to improve and sustain the productivity of wheat-maize-rice cropping system. Therefore, the experiment was initiated to promote the intervention of maize in rice - wheat cropping system suggesting appropriate soil and nutrient management to achieve improved and sustainable system productivity and thereby contribute to food security of the country. The experiment comprises the combination of four levels of nutrient management and four levels of soil management tested in split plot design. Nutrient management treatments namely control, recommended rate of chemical fertilizers (RF), integrated plant nutrient system based fertilizers using 5 t ha^{-1} cow dung (IPNS) and recommended fertilizers plus 5 t ha^{-1} cow dung (RF+CD) were assigned in main plots and four soil management treatments namely sowing of wheat seed in raised bed (Bed), bed with rice straw mulching @ 3 t ha^{-1} (Bed+mulch), conventionally sowing of wheat in flat soil (flat) and sowing in flat with rice straw mulching @ 3 t ha^{-1} (Flat+mulch) were imposed in the subplots. The field experiment was initiated at the central farm of Bangladesh Agricultural Research Institute, Gazipur stating with wheat crop in 2009-10

The result indicated that soil management treatments had significant effect on surface soil moisture content that contributed to stand establishment both for wheat and maize crop. Application of rice straw as mulch 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 of wheat and cobs/m^2 of maize which ultimately contributed to yields of wheat and maize crops. 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 flat or bed 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 in previous wheat and maize crops had the similar residual effect on rice yield.

Effect of conservation agriculture practices on soil property and productivity in wheat-maize-rice cropping system

The major concepts of conservation agriculture (CA) are the minimum disturbance of soil and keeping crop residue in the field which improve soil quality preventing soil erosion and leaching of nutrients. Also mulching effect of crop residue retention contribute to productivity by minimizing several production constrains like water stress, weed infestation and favoring production factors like retention of residual moisture, root growth and N use efficiency. However, most of the CA works reported either in single cropping or double cropping system. The intervention of CA practice in triple cereal system is scares. Therefore, the experiment was under taken to evaluate the performance of wheat-maize-rice cropping system under different CA practices in order to identify the appropriate CA practice capable in improving system productivity. Another objective was to study the change in soil properties due to shifting from conventional to conservation agricultural practice. In the context, the field trial was initiated at research farm of BARI, Gazipur starting with a wheat crop in 2010-11. The trial comprises four levels of conservation practices imposed in the component crops under wheat-maize-rice cropping system in randomly complete block design. The four different treatments are: T_1 = Conventional practice which consists of broadcasting wheat seeds in well till soil followed by line sown maize following puddle transplanted (PTP) aman rice; T_2 = Conservation practice, consist of wheat sowing using single pass of PTOS (Power tiller operated seeder) in post rice harvested plot with standing rice straw (20-25 cm) followed by no-till maize in post wheat harvested plot with standing wheat straw (25-30 cm) and then PTP rice; T_3 = Bed Planting, that includes wheat sowing using PTOBP (Power tiller operated bed planter) followed by no till maize on the top of the bed opening a furrow between two lines of wheat following PTP rice; T_4 = Conservation practice in Bed which is similar to T_3 but includes standing rice and wheat straw retention.

The result indicated that conservation practices of keeping standing crop residue in the field with the minimum disturbance of soil have significant contribution on grain yield of wheat and maize compare to conventional practice of well-till without crop residue retention. Conservation practices either in bed planting condition or in flat condition was equally effective in improving yield components and yield of wheat and maize. 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 and thereafter rice yield also improved in response to residual effect of conservation practices.

Evaluation of wheat genotypes through nutrient addition trial

During the variety development process, the trials are conducted in different agro-ecological regions under the recommended rate of fertilizers thus the varietal response to fertilizer elements and their efficiency to individual fertilizer element remained unknown. Again the soil fertility and climatic conditions are changing and simultaneously the new wheat genotypes with higher yield potential are developing and expanding at the farm level. In recent years the wheat crop is being exposed to environmental stress like drought, heat and salinity and at the same time the crop also facing the nutritional deficiencies under the upland soil condition different regions of Bangladesh. Under such a condition more adaptive and robust wheat genotype needed to identify to achieve higher and sustainable productivity. The crop response to fertilizer elements varied with the variation of genotypes and there are differences in nitrogen use efficiency among wheat genotypes. The response of newly developed wheat varieties and advanced lines to fertilizer element need to be investigated to promote the efficient variety in order to improve wheat yield under soil nutrient deficit condition in Bangladesh. Moreover, the understanding of the genotype fertilizer interactions of advanced wheat lines might be useful in selecting fertilizer use efficient variety. Fertilizers are the expensive input and most of the fertilizers are being imported at the cost of valuable foreign currency. Thus the information on efficiencies of the new genotypes to fertilizer element might be useful in ensuring judicious fertilizer application. The more efficient variety or advanced line is preferable for the wider adoption and expansion throughout the country. Also the basic information on nutritional deficiency of wheat in our environment might be helpful to enrich the wheat knowledge bank of Bangladesh. Therefore the experiment is designed to investigate and explore the varietal potentials in improving wheat yield identifying the nutrient efficient genotype. Field experiments were initiated at the research farms of RWRC, Joydebpur, RWRC, Rajshahi and WRC, Dinajpur during 2013-14 and 2014-15 wheat season to examine the responses of five wheat genotypes to seven levels of fertilizer treatments in split plot design. Seven levels of fertilizer treatments assigned in the main plots were: Control (Native fertilizer), recommended rates of nitrogen (N_{120}); nitrogen and phosphorus ($N_{120}P_{30}$); nitrogen, phosphorus and potassium ($N_{120}P_{30}K_{50}$); nitrogen, phosphorus, potassium and sulfur ($N_{120}P_{30}K_{50}S_{20}$); nitrogen, phosphorus, potassium, sulfur and zinc ($N_{120}P_{30}K_{50}S_{20}Zn_5$); and nitrogen, phosphorus, potassium, sulfur, zinc and boron fertilizer ($N_{120}P_{30}K_{50}S_{20}Zn_5B_2$). Five wheat genotypes distributed in the subplots were: BARI GOM 26, BARI GOM 27, BARI GOM 28, BAW 1151 and BAW 1161.

The Maximum yield was recorded at Dinajpur followed by Joydebpur and Rajshahi. 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 x fertilizer levels**,** location x nutient levels and nutrient level x genotypes. Among the wheat genotypes BARI GOM 30 produced the maximum yield followed by BARI GOM 27 and BARI GOM 29. Application of N fertilizer was very effective to increase wheat yield over the control for all the locations. The crop response to applied P was non-significant for Joydebpur but significant for other locations. Wheat yield was improved significantly improved in Joydebpur under K application. There were various additive effects of additive nutrients and needed to clarify by further study.

Study the yield potentials of promising wheat genotypes maximizing fertilizer application

A field trial was conducted in three locations, one in fine textured (Silty clay) soil of Bangladesh Agricultural Research Institute (BARI) Joydebpur, medium textured soil of Regional Wheat Research Centre, Rajshahi and light textured soil of Wheat Research Centre, Dinajpur during 2014-15. In this trail, the response of eight wheat genotype was examined at four levels of high fertilizer starting from recommended dose. The four fertilizer treatments of recommended NPKS fertilizers (RF), 150% of RF, 150% RF+ Cow-dung (CD) @ 5.0 t/ha and 150% RF+ CD @ 10.0 t/ha were applied in main plots and eight wheat genotypes (BARI GOM 28, BARI GOM 29, BARI Gom 29, BAW 1163, BAW 1170, BAW 1177, BAW 1182 and SSW-1) were grown in the sub plots in split plot design. The size of each subplot was 5m X 2m. Fertilizers of 120 kg N, 30 kg P, 50 kg K and 20 kg S ha^{-1} were applied as urea, triple super phosphate, muriate of potash, and gypsum, respectively, considered as the recommended rate of fertilizer. All fertilizers including two-third urea were uniformly applied in the field during final land preparation. The rest of urea was top dressed at the crown root initiation (CRI) stage at 21 days after sowing (DAS). The crop was irrigated thrice to bring the soil moisture near to field capacity, during CRI, booting and grain-filling stages. Weeds were controlled once at 30 DAS manually by hand weeding. The crops of all the plots were under intensive observation to record the accurate date of booting, heading, anthesis and maturity.

At Joydebpur, Dinajpur and Rajshahi during 2014-15 wheat growing season to investigate the response of recently developed three wheat varieties and five 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 g rains/spike. Among the varieties BARI Gom 30 produced maximum yield. Among the advanced lines BAW 1170 performed higher yield in all locations that was similar to BAW 1182. Also both 1170 and BAW 1182 were more responsive to added higher fertilizers.

Disease Management

Response of wheat lines to Bipolaris leaf blight under inoculated condition

A total of 64 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 last week of mid 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.

Severity of BpLB expressed as % DLA on flag leaf varied greatly among the different lines and varieties tested under inoculated condition. The disease severities ranged from 1% in Chirya 7 and Milan/Sha 7 to 99% in CIANO 79. Based on the disease severity assessed on flag leaf, 18 lines were graded as resistant (up to10% DLA), 17 moderately resistant (11-30% DLA), 15 moderately susceptible (31-50% DLA), 6 susceptible (51-70% DLA) and the rest 8 as highly susceptible (more than 70% DLA).

Germplasm evaluation of wheat against Bipolaris leaf blight

A total of 100 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/2014 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. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield.

Out of 100 entries tested, 19 lines were selected based on AUDPC, grain yield and other agronomic characters. Among the selected lines, entry no. 54 was selected in all locations, 4 entries (38, 46, 47 and 92) in two locations and others in one location. The AUDPC of the selected lines ranged from 186 to 395, while those of the susceptible check varieties ranged from 282 to 700. Grain yields of the selected lines varied between 345 and 494 g/plot, whereas 275 to 537 g/plot were obtained from the check varieties. Days to heading, plant height and 1000-grain weight of the selected lines were also within acceptable limit as compared to the check varieties.

CSISA spot blotch screening nursery

The 6th CSISA spot blotch 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/2014 under irrigated condition. The design of the experiment was Alpha Lattice with two replications. 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. The AUDPC was calculated. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. The entries were scored on 0-5 scale for their general agronomy in the field.

Out of 52 lines tested, 13 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. 6743 was selected in all locations and 8 entries (6702, 6714, 6715, 6718, 6720, 6722, 6741 and 6744) were selected in two locations. The AUDPC of the selected lines ranged from 307 to 459, while those of the susceptible check varieties ranged from 289 to 660. Grain yields of the selected entries varied between 366 and 517 g/plot, whereas 251 to 474 g/plot were obtained from the check varieties. 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.

Stem rust resistance screening nursery

The 9th SRRSN consisting of 250 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. Recommended fertilizers were applied and regular agronomic practices were followed for normal crop growth. Rust was scored on modified Cobb scale. Severity of BpLB was scored on double-digit scale (00-99) converted to percent diseased leaf area (% DLA) and AUDPC was calculated. 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 250 entries tested, 17 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. All the selected lines were free from leaf rust infection, while the check variety Prodip showed 40MS reaction. Among the selected lines, entry no. 130 was selected in all locations and the others in two locations. AUDPC of the selected lines ranged from 267 to 393, while the susceptible check varieties showed the AUDPC value 348 and 440. Grain yields of the selected entries varied between 343 and 436 g/plot, whereas 420 to 478 g/plot were obtained from the check varieties. 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

A total of 55 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 mid 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.

Severity of leaf rust varied among different lines and varieties tested under inoculated condition. The advanced lines showed only 0-10% severity with different types of disease response, while 40% severity with MS type reaction was recorded in Prodip and 60% severity with susceptible reaction was observed in Morocco. Based on disease severity all the advanced lines were found resistant to leaf rust infection.

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

The leaf rust susceptible variety Prodip and slow leaf rusting variety BARI Gom 26 were sown at seven different dates. Sowing commenced from 17 Nov. 2014 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 C, B x C and A x B x C for grain yield. Severity of leaf rust and losses in 1000-grain weight and grain yield varied between the varieties Prodip and BARI Gom 26 used in the present investigation. Losses recorded in Prodip were higher than BARI Gom 26 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.

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

Six fungicides of different groups were tested for their efficacy against Bipolaris leaf blight and leaf rust of wheat. 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. Seeds were sown in 1.2 x 2 m plots with 20 cm row-spacing on 18 December. The experiment was laid out in RCB design with three replications. Recommended doses of fertilizers were used and three irrigations were applied during the crop cycle. Disease severity was scored as percent diseased leaf area (% DLA) on 10 flag leaves of 10 main tillers selected randomly in each plot. 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 Tilt, which was similar to Topzim Super, Bension, Storm, Ramoni and Fasal Hexa. The unsprayed plot showed the highest disease severity. The percent disease reduction by the very effective fungicides ranged from 99% over unsprayed plot. The highest grain yield was obtained with Storm, and the increase in yield by this fungicide over unsprayed control was 84%, which was followed by Topzim Super, Fasal Hexa, Tilt, Ramoni and Bension.

Significant control of leaf rust was also observed with foliar sprays of Tilt, Topzim Super, Storm, Ramoni, Bension and Fasal Hexa in controlling the disease. The unsprayed plot showed the highest disease severity. The lowest disease severity was recorded with Tilt, Topzim Super, Storm, Ramoni, Bension and Fasal Hexa. The effective fungicides controlled the disease by 100% with 420-504% increase in grain yield over unsprayed plot. The highest increase in grain yield was obtained with Bension, which was followed by Storm, Topzim Super, Ramoni, Fasal Hexa and Tilt.

Climate change adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight

The experiment was conducted at WRC Dinajpur and laid out in split-split plot design with two replications. Two sowing dates, 24 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 1135, BAW 1157, BAW 1170, BAW 1177, 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). Recommended doses of fertilizers (100:60:60:20 kg N:P_2O_5:K_2O:S per ha) were used and 3-4 irrigations were applied during the crop cycle. Weeding was done once at 25-27 days after sowing. 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) and converted to percent diseased leaf area (% DLA). The AUDPC was calculated. Agronomic data were recorded on days to heading, plant height, days to maturity, biomass, 1000-grain weight and grain yield. The harvested area was 1.6 m^2 (2 m long 4 rows). Data on BpLB severity and grain yield were subjected to analysis of variance using MSTAT-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 1182 showed the lowest disease severity, which was followed by Shatabdi, BAW 1177, BAW 1200 and BAW 1194. 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 1177 gave the highest grain yield which was followed by BAW 1202, BAW 1203, BAW 1182, BAW 1170 and

BAW 1194, 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 1194 followed by BAW 1170 and BAW 1157, and highest in BAW 1135 followed by Kanchan, BAW 1200, BAW 1202 and BAW 1177. Yield loss due to BpLB disease was found lowest in BAW 1182 followed by BAW 1202, BAW 1194 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, while the lowest was recorded in BAW 1194 followed by BAW 1170 and BAW 1182. However, the yield reduction due to late planting was more pronounced than to BpLB disease.

Monitoring in international disease trap nurseries

Four different disease trap nurseries were received from ICARDA-Syria under ICARDA-CIMMYT Wheat Improvement Program and from IIWBR-India under SAARC collaboration. The nurseries were planted in the research fields in five different locations: Dinajpur, Joydebpur, Jamalpur, Jessore and Rajshahi. Sowing was done in mid December according to the plan supplied for respective nurseries. The seeds of each entry were sown in 1 m long single or 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 rust was not found and stem rust occurred with low severity, but leaf rust was observed with varying levels of severities. In the SAARC Nursery, leaf rust ranged from 0-5S, while it varied from 0-70S in International Leaf Rust Trap Nursery (6^{th} ILRTN), 0-30S in International Stem Rust Trap Nursery (10^{th} ISRTN) and 0-50S in International Yellow Rust Trap Nursery (9^{th} 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 (6^{th} 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 *Lr2c, Lr3, Lr3bg, Lr10, Lr13, Lr17, Lr18, Lr23, Lr26, Lr(10, 27+31), Lr29, Lr30, Lr32, Lr33* and *Lr34* showed low (0-20%) disease severity with different types of reactions. Higher leaf rust severity was recorded in Dinajpur and Jessore compared to other locations.

Wheat rust surveillance in Bangladesh

Pathologists and breeders took part in monitoring of wheat rusts in farmers' fields and trial sites. A total of 105 fields of the major wheat growing areas were covered in the current season (2014-15). The survey work was implemented collaborating different stations of WRC: Dinajpur, Joydebpur, Jessore, Jamalpur and Rajshahi. Disease assessment was made following the modified Cobb scale. The BGRI protocols and format were used during the present survey.

2015 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 40% of the 105 fields surveyed had leaf rust, but almost 93% of the infected fields showed low (<20%) and only 7% showed moderate (20-40%) disease levels. 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 popular variety Prodip showed low to moderate disease levels with MS-S type reactions, whereas BARI Gom 25 and BARI Gom 26 displayed only low disease severity with

MRMS-MSS responses. Other six varieties, namely Shatabdi, Bijoy, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were free from leaf rust infection in the farmers’ fields of all the locations. Stem rust was found only at WRC, Dinajpur with susceptible type of reaction. But the incidence and severity of the disease was very low. The disease was observed on few lines in the trap nurseries from ICARDA, but not in any other cultivars or lines. The symptoms and urediospore morphology were examined and ascertained to be of stem rust. Samples were collected and sent to IIWBR Regional Station in Shimla, India for race analysis. Yellow rust was not found in any of the wheat growing areas surveyed. The disease is infrequent in Bangladesh, but does occur occasionally with sporadic infection, particularly on susceptible variety Morocco.

Farm Mechanization

Adoption of power tiller operated seeder (PTOS) in rice-wheat cropping system

Power tiller operated seeder (PTOS) is called minimum tillage 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 levelling 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 farmers’ fields of Dinajpur, Thakurgaon, and Rajshahi area in 2014-15. Recommended basal dose 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 planted after rice harvest and mungbean, sesame, jute planted after wheat harvest. The density of rice residue was 0.8-1.4 t/ha. PTOS 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 conventional method. Minimum tillage by PTOS saved irrigation water for wheat, maize and rice 14.9%, 5% and 30%, respectively compare to traditional irrigation method of crop cultivation. In dry surface condition of rice field no crack formation on the surface but in conventional puddling plots surfaced cracked. It is environment friendly, minimum disturbance soil and saved diesel fuel 94 lit./ha/yr. Minimum tillage 44% less CO_2 emission into the atmosphere which less polluted the environment. Wheat yield was 25.5% higher than conventional method. Effective field capacity was 0.15ha/hr. Cost of wheat seeding was Tk. 1950/ha which was 65.8% less than conventional method (Tk.5695.0/ha). PTOS covers about 4003 ha land in Rajshahi and Dinajpur area. There are about 730 seeders in the country which cover about 29000 ha land.

Fine tuning of power tiller operated bed planter

A power tiller operated bed planter has been improved and fine-tuned with locally available materials in Wheat Research Centre, BARI Rajshahi and adaptive trials were conducted in the farmers’ fields of Rajshahi and Dinajpur area in 2014-15. 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 enhances 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 over come land boundary (aiel). A Saifeng type bed planter also developed first time at BARI Rajshahi. There was only Dongfeng type bed planter was available earlier. The bed planter formed a trapezoidal shape raised bed and can perform seeding and fertilizing operations on the top of the bed simultaneously in one operation. The bed planter is to be attached behind the power tiller (these are readily available in Bangladesh with reports of up to700,000 within the 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 maize yield were 4.8 t/ha and 8.3 t/ha, respectively. The same wheat and maize yield in conventional method were 3.5 t/ha and 8.1 t/ha, respectively. Yield advantage was 33% over conventional method. Net return for wheat cultivation in bed planting is 1.2 times than conventional system.The bed planter is now using as custom hire basis in the farmers field. There are about 6325 ha lands under bed planting system.

On farm validation of zero tillage planters for up land crops production

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. A low cost and robust power tiller driven (12Hp) zero-till planter has been improved with inclined plate seed meter assembly in Wheat Research Centre, BARI, Rajshahi with locally available materials for seeding different kinds of seeds. This is a pull type implement hitched with tiller at the drawbar point replacing the regular tilling part of it. The validation trials of zero-till planter with weed control management were conducted in the farmer's field in Rajshahi areas for wheat, maize, and pulses establishment during the year 2011-2014. The planter can pull 4 tynes in soft and medium hard soil but 3 tynes for hard soil. The planter was capable to apply seed and fertilizer in an opening slit of width 30mm and depth 60mm. 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 farmers saved plant establishment cost 50-65%, and minimizing 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/hr and Tk.1900.0/ha, respectively. Fertilizer management, weed control and selection of right crop variety with proper crop rotation are the key issue for adopting this new technology.

Design and development of a manually operated adjustable multi-row seeder for up land crops

A manually operated adjustable multi-row seeder was designed and fabricated in the workshop of Agricultural Engineering Division of WRC, Dinajpur in 2015 for seeding of different upland crops. Locally available steel materials were used to fabricate the seeder. The roller type seed metering device was considered for different seed sowing. The distance between the lines to line is adjustable and the depth of seeding is also adjustable. Fabrication of the seeder was completed and detail performance evaluation of the seeder to be conducted next year.

Design and development of a manually operated adjustable multi-row weeder for up land crops

Weed is one of the major problems in crop production. Different weeds are responsible for reducing the quality and yield of crops as well as farmer's income. A manually operated adjustable multi-row weeder was designed and fabricated in the engineering workshop, WRC, Dinajpur in 2015 for weeding of different upland crops. The weeder is fitted with maximum three numbers of blades that can be reduced as per requirement. The distance between the blades and the depth of weeding are adjustable.

Fabrication is completed and field evaluation of the weeder will be conducted in the next cropping season.

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 RWRC, BARI Rajshahi 2015. 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 first time under this programme in Rajshahi.

Technology validations and transfer

Variety and management technology transfer

Wheat is the second most important cereal crop in Bangladesh. Its consumption is increasing @ 3% year^{-1}, but production is not increasing as required. The major reasons are the reduction of area under wheat and low yield due to inadequate technology adoption. The average wheat yield in research station is around 4.5 t ha^{-1}, but the national average yield is around 3.0 t ha^{-1}. This huge yield gap is due to inadequate technology adoption. In this situation, technology transfer activities are to be expedited to increase wheat yield. Therefore, technology transfer activities like demonstrations, trainings, workshops, field days, publications in press and electronic media were undertaken by WRC to enhance technology adoption, get feedback from farmers and extension officials and increase wheat yields reducing yield gap by minimizing farmers' knowledge gap.

One thousand twenty six demonstrations were conducted with four wheat varieties viz., BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 in the farmers' fields of 8 agricultural regions in 2014-15. The mean yield of the demonstrations conducted by DAE of all four varieties was 3646 kg ha^{-1}. BARI Gom 28 produced the highest yield (3932 kg ha^{-1}) followed by BARI Gom 26 (3594 kg ha^{-1}), BARI Gom 25 (3590 kg ha^{-1}) and BARI Gom 27 (3467 kg ha^{-1}). Whereas, the mean yield of the demonstrations conducted through OFRD, ARS, WRC, CSISA & NGOs of all 4 varieties was 3702 kg ha^{-1}. The highest mean yield was recorded in BARI Gom 26 (3890 kg/ha) followed by BARI Gom 25 (3675 kg/ha). The highest mean yield was obtained from Jessore region (3938 kg ha^{-1}) that was significantly higher than all other locations except Dhaka (3794 kg ha^{-1}) and Mymensingh region (3718 kg ha^{-1}). The lowest yield was found from Rajshahi (3424 kg ha^{-1}) region. The mean yield was 3678 kg ha^{-1} of demonstrations conducted through all organization (DAE, OFRD, ARS, WRC, CSISA & NGOs) and all locations. BARI Gom 28 produced the highest yield (3772 kg ha^{-1}) followed by BARI Gom 26 (3750 kg ha^{-1}) and BARI Gom 25 (3636 kg ha^{-1}). The highest mean yield was given by BARI Gom 28 (3772 kg ha^{-1}) followed by BARI Gom 26 (3750 kg ha^{-1}) and BARI Gom 25 (3636 kg ha^{-1}). Yield of these three varieties was statistically similar but significantly higher than BARI Gom 27 (3554 kg ha^{-1}). The demonstration farmers have preserved 99805 kg (77563+22242) of seeds of the new varieties. The highest quantity (33506 kg) of seed was stored in Rajshahi region which was followed by Jessore region (25897 kg). In total 58455 farmers of the same and neighbouring villages visited the demonstrations and expressed their interest to collect seeds of new varieties in next year. The results demonstrated that all of latest four varieties (BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28) were preferred by the farmers. This will help increase yield and diversity of these varieties in farmers' fields.

Block demonstration for reducing yield gap

BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 were demonstrated in one acre blocks (each variety in 25 decimal plots) at farmer’s field of Thakurgaon, Rajshahi, 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 06 December 2014. Signboards were placed in all demonstration plots. 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.

The highest mean yield over locations was recorded in BARI Gom 26 (4186 kg/ha) followed by BARI Gom 28 (3945 kg/ha). The mean yield of wheat under farmers’ own input and management was 3271 kg/ha and overall mean yield of the new four varieties was 3976 kg/ha. The difference between these two yields (yield gap) was highly significant. 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. The participating farmers were very much interested to cultivate new varieties of wheat and they also preserved a lion-share of their harvest as seeds.

Field days were also organized in those yield maximization demonstrations where hundreds of farmers, DAE personnel and public representatives participated. Participating farmers in the field days were also very interested to collect the seeds of those new varieties for next years. Many of the farmers requested for seeds of BARI Gom 26 and BARI Gom 28. So, it is expected that yield maximization demonstrations will help rapid popularization and dissemination of new varieties through farmers to farmers seed spread. Actually the yield gap is mainly due to management gap (knowledge gap of the farmers about proper management) and gap due to improved variety. The poor farmers cannot provide proper irrigation, fertilizer and other essential inputs for wheat cultivation. So, the management gaps are the main cause of yield gap in wheat.

Adaptive trial of wheat

Twelve adaptive trials with six new varieties of wheat were conducted at the farmers’ fields of Rangpur, Nilphamari, Lalmonirhat and Kurigram districts to test the suitability or adaptation of these wheat varieties under IAPP. Significant effects of location were observed on yield and yield related traits. The highest yield (5894 kg/ha) was recorded at Rangpur mean of 3 locations followed by Nilphamari (5188 kg/ha) mean of 3 locations and the lowest yield recorded at Kurigram3 location (3629 kg/ha) due to lodging by hail-storm. Significant yield differences were observed among the genotypes tested. The highest yield was recorded in BARI Gom 29 (4800 kg/ha) and the lowest in the variety used by the neighbouring farmers (3310 kg/ha). Similarly, 1000-grain weight (TGW) was significantly varied. The highest TGW was found in BARI Gom 25 (53.3 g) followed by BARI Gom 29 (50.9 g) and the lowest in the variety used by the neighbouring farmers (43.4 g). The variety BARI Gom 29 was shorter than all other varieties. The yield of the variety used by the farmers (Shatabdi/BARI Gom 26) was very low due to low fertilizers used and poor field management.

Block demonstration of wheat

Two wheat varieties, BARI Gom 26 and BARI Gom 28 were demonstrated in 40 decimal blocks. The crop was grown using recommended management technologies. Yield was recorded from demonstration and neighbouring farmers’ fields. Significantly higher yields were obtained from BARI Gom 26 (4061 kg/ha) and BARI Gom 28 (3969 kg/ha) over farmer’s variety (2540 kg/ha). About 590 kg seed of BARI Gom 26, 590 kg seed of BARI Gom 28 and 160 kg seeds of BARI Gom 25 were preserved by the farmers. Neighbouring farmers cultivated wheat under poor management using lower rate of fertilizer than recommended dose.

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 were grown 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 (4011 kg/ha) over farmer's variety (2808 kg/ha). Significant higher yield was also obtained from BARI Gom 26 (4475 kg/ha) over farmer's variety (3378 kg/ha). Significantly higher yield was also obtained from BARI Gom 27 (3850 kg/ha) over farmer's variety (3030 kg/ha). Significantly higher yield was also obtained from BARI Gom 28 (3874 kg/ha) over farmer's variety (2839 kg/ha). BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 yielded 42.84 %, 32.47 %, 27.06 % and 36.46 % respectively more than the neighbouring farmer's variety. About 1290 kg seed of BARI Gom 25, 1320 kg seed of BARI Gom 26, 970 kg seed of BARI Gom 27 and 1000 kg seed of BARI Gom 28 were preserved by the farmers involved in these trials.

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

Two trials were conducted at two villages of Rangpur and Lalmonirhat districts under IAP Project. Power tiller operated seeder (PTOS) and bed planter were used for planting wheat directly in the farmers' fields. Seed of the wheat varieties treated with Provax-200 and recommended dose of fertilizers were supplied to the farmers from IAPP. Fertilizers were broadcasted before seeding operation. There was significant yield difference between seeding by PTOS and conventional method used by the farmers. Yield of wheat by PTOS and farmer's practice (broadcast seeding with power tiller) were 4732 kg/ha and 3712 kg/ha, respectively. Yield of wheat seeded by PTOS was 27.48 % higher over farmer's practice. Whereas, the yield of wheat seeded by power tiller operated bed planter was 4825 kg/ha. Yield of wheat seeded by bed planter was 30.06 % higher than farmer's seeding practice. About 550 kg seed of BARI Gom 26 were preserved by the farmers involved with the trials.

Block demonstration of acid soil management

Four trials were conducted at four villages of Rangpur, Nilphamari, Kurigram and Lalmonirhat district. Half of each block (20 decimal) was treated with 80 kg dolomite lime ('Dolochun'). Seed of BARI Gom 26 treated with Provax-200 was supplied to the farmers with other inputs from IAPP. The crop was grown using recommended management technologies. Significantly higher yield were obtained from the plot with Dolochun application (4375 kg/ha) than the plot without Dolochun (3688 kg/ha). About 18.63 % more yield was obtained by applying Dolochun. About 27.08 % more yield was obtained from the plot without lime than the neighbouring farmer's plots also without lime application. This may be the effect of the difference in management factors like fertilizers, irrigation, weed control, etc. From the trials 660 kg seed of BARI Gom 26 were preserved by the farmers.

Training

Farmers and 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 programme 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.

A total of 4867 personnel from different organizations attended training programmes of Wheat Research Centre given on different aspects during 2014-15. Out of those, 3819 farmers and 1048 SAAO/SSA/SA and NGO's field staff were trained on wheat technologies and 198 extension and NGO Officers were 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.

Workshop

Wheat Research Centre, BARI, organized two workshops during 2014-15 on different aspects of wheat production with farmers, researchers, DAE, SCA, BADC and NGO personnel. One workshop on "Quality wheat seed production and supply" was held at WRC, Dinajpur in March, 2014 and another "Pre-review workshop" was also held at WRC, Dinajpur in May, 2014. A total of 85 participants attended those workshops

In those workshops, present situation, prospect and constrains of quality wheat seed production and supply in the country were discussed. The participants have made some suggestions regarding improvement of quality wheat seed production and supply and WRC activities. Their suggestions were critically discussed with the researchers and future research programmes will be undertaken accordingly. Through these workshops research programmes were improved, linkage among different organizations became strong and information on new varieties and latest production technologies were transferred.

Field day and visits

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, and Imams from greater Rangpur region also visited the activities of WRC. WRC technologies were presented to them during their visit. Four field days were organized by WRC, Dinajpur in seed production and block demonstration plots where about 1200 farmers, 80 DAE, NGO and related personnel and 10 local people representatives were present. Honourable Chief Whip of National Assembly was present in a field day at Baufal, Patuakhali. The participating farmers in the field days were very much interested to cultivate new varieties of wheat. Twenty four thousand copies of coloured pictorial leaflets on BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28 were printed and distributed among the farmers and related personnel.

Maize

A. Characterization Maintenance of Germplasm

Maintenance and seed increase of promising inbred lines of maize

Seventy one new exotic inbred lines (set-I: 45 and set-II: 26) from CIMMYT and six existing lines (Set III: 6) were maintained through selfing to increase seeds for using in future breeding program.

B. Development of Source Popular & Inbred lines

Recycling for development of maize inbred lines

Superior inbred lines are desirable for the development of better hybrids. In order to develop superior inbred line(s), the commercial hybridIM8013 was advanced to S_1 generation from S_o and 40 self dears (S_1) were selected& presented next generation advancing.

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

Inbred lines of maize are prerequisite for the development of hybrids. Extraction of superior inbred lines through recycling is a common technique in maize breeding. The balanced bulk seeds of S_1 field corn lines, Set I:Titan, Set II: 9120, Set III: 50 S_1 lines of base population(early and dwarf), Set IV : 50 S_1 lines of base population(medium height and high yield goal) and Set V:American pop corn, were advanced to S_2 generation and 45, 40, and 80 self dears collected from Titan, 9120, American pop corn, respectively and one cob from each S_1 line for50 S_2lines of base population(early and dwarf; medium height& high yield) were selected& preserved separately for advancing them to next generation.

The balanced bulk seeds of S_2 field corn lines of six sets (Set I: Pinacle, Set II: 981, SetIII: Arun 4, Set IV: Seeds New, Set V: BARI Sweet corn 1 and Set VI: Pop corn Nepal) were advanced to S_3 generation. Variations were found among the S_2 lines for different traits. Finally 55, 44, 121, 39, 35 and143 selfed S_3 ears form the above respective S_2 generation were preserved for advancing them to S_4 generation for developing test cross hybrids.

Twenty eight S_3 lines of commercial hybrid 981and pioneer were advanced to S_4 generation following ear to row method. Variations were found among the lines for different traits. Total 103 and 95 selfedears were selected for next generation advancing.

Two sets of S_4 Baby corn hybrids *viz.* Victory super (36 S_4lines) and KH101 (39 S_4lines), two sets of Popcorn varieties *viz*. Thai popcorn(18 S_4lines) and Popcorn burst(20 S_4lines) and one set of field corn hybrid7074(28 S_4lines) were advanced to S_5 generation in order to develop superior inbred line(s)following ear to row method. Variations were found among the S_4lines. Selected plants were selfed and S_5 seeds were preserved for advancing them to S_6 generation.

Seven sets of S_5 lines of field corn hybrids viz. SetI: 900 M Gold (19 lines), Set II: Pacific-60 (15 lines) and Set III: Uttaran-2 (20 lines) and Set IV: Pinacle (30 lines), Set V:QY 11 (27 lines), Set VI: Wang 11(32 lines), Set VII:NT6323(30lines),one set of baby corn BCP-271(31lines) and one set of pop cornhybridPop-P622 (15 lines) were advanced to S_6 generation following ear to row method. The plants were seemed to be mostly uniform in height. Selected S_5 plants were selfed and finally selected crosses were preserved for next generation advancing.

This is the final stage of inbred development through recycling. In this generation, thirteen S_6 lines of NK46 were advanced to S_7 generation in order to develop superior inbred line(s)following ear to row method. There was no variation among the plants and those were supposed to attain honozygosity. These fully developed inbred lines will be used in hybrid development.

C. Evaluation of Inbred Lines Through Line× Tester Method and North Carolina Design II

(i) Evaluation of inbred lines of maize through line × tester method (8 sets)

Field corn

In set I: SevenS_3lines of commercial hybrid 7074 were crossed with 3 testers in a Line × Tester mating design and the resulting 21 crosses along with the parents and standard check BHM 9 and NK 40 were evaluated in alpha lattice design with two replications at Gazipur. Among the line parents,7074/S_3-1, 7074/S_3-5, 7074/S_3-8 and 7074/S_3-11 and testers BML-36 and CML-425 were good general combiners for grain yield and some of the important yield contributing characters. Three crosses (7074/S_3-1×BML-36, 7074/S_3-5×CML-425, 7074/S_3-8×CML-425) showed high sca effects & high mean performances (11.93-13.83 t/ha) for yield could be used for commercial hybrid development.

In set II: Nine teen lines were crossed with 2 testers in a Line × Tester mating design to produced38 crosses. All the crosses along with the parents and standard checks BHM 9 were evaluated in alpha lattice design with two replications. The parents E7, E10, E15 and E19 could be used in hybridization program as donor. Better performing three crosses (E14×BIL95, E17×BIL79 and E4×BIL95) showed high heterosis over check &also had high mean yield (10.44-12.55 t/ha) were selected to evaluate in multilocation trial.

In set III: the experiment was conducted with 10S_4 lines crossed with 3 testers in a Line × Tester mating design and the resulting 30 crosses along with the parents evaluated in alpha lattice design with three replications at RARS Rahmatpur, Barisal. The inbred parents SP10, SP4, and SP8 were found as the good general combiner for yield. Two crosses P2×BIL-106, P5×BIL-110 and P6×BIL-28showed high mean yield (12.91-15.70t/ha) were identified as the best combinations.

In Set IV: 26 S_4 lines of commercial hybrid ‘Pinacle’ were crossed with 3 testers in a Line × Tester method and the resulting 78 crosses along with parents and two checks (BHM 9 and NK40) were evaluated in alpha lattice design with two replications at Gazipur. Eight lines viz. Pinacle/S_4-1, Pinacle/S_4-2, Pinacle/S_4-5, Pinacle/S_4-6, Pinacle/S4-15, Pinacle/S_4-19, Pinacle/S_4-28 and Pinacle/S_4-30 were found good combiner for grain yield. Three crosses Line 15×BIL 79, Line 5×BIL 79 and Line2×BIL 106 showed high SCA, high heterosis (7.46-12.30% over check NK40)& high mean yield (13.11-13.70 t/ha) were selected as the best combinations. These crosses could be utilized for commercial hybrid after verification.

Pop corn

In Set VI*:* Eight S_3 lines of Thai pop corn were crossed with 3 testers in a Line × Tester mating design. The resulting 24 crosses along with two checks (NI5820 and Khoi bhutta) were evaluated in alpha lattice design with two replications at Gazipur. The predominance of non-additive gene action for useful traits suggested the improvement of the trait though heterosis breeding. Interaction contributed minimum for both yield and quality traits to total variance. The lines Thai Pop/S_3-28 and Thai Pop/S_3-20 were identified as the good general combiners for popping quality. The good combination crosses were Thai pop/S_3-1×PCB/S_6-13, Thai pop/S_3-17×PCB/S_6-39 and Thai pop/S_3-20×PCB/S_6-39showed high mean grain yield (5.43-6.89 t/ha) and quality traits like popping percentage (95.5-96.0%), popping expansion (16.11- 30.81) and had good taste of quality could be used in future breeding program to develop high yielding popcorn hybrids after their verification.

Baby corn

In set V: Seven S_4 lines of baby corn hybrid BCP-271 were crossed with 3 testers in a Line × Tester mating design and the resulting 21 crosses along with parents and standard check‘ Baby star’ were evaluated in alpha lattice design at Gazipur. Results showed that both additive & non-additive gene effects were important for controlling the trials. Interaction for both fodder & baby corn yield contributed maximum to the total variance. Among the lines BCP/S_4-29 and BCP/S_4-31, and testers VS/S_3-1 and VS/S_3-26 were found good general combiners for baby corn yield. Five crosses BCP/S_4-2×VS/S_3-1, BCP/S_4-5×VS/S_3-8, BCP/S_4-10×VS/S_3-8, BCP/S_4-22×VS/S_3-26 and BCP/S_4-29×VS/S_3-1produced higher number of cobs (4 cobs/plant) and shorter harvest duration (6 to 9 days) were selected for further verification.

In set VII: a Line × Tester analysis was conducted in baby corn involving 8 selected S_3 lines and 3 testers. The produced 24 F_1's along with parents and one check 'Babystar' were evaluated in alpha lattice design with two replications at Gazipur. The lines KH-101/S_3-1, KH-101/S_3-39 were identified as the good general combiner for cobs/plants. Three crosses KH-101/S_3-39×VS/S_3-24, KH-101/S_3-44×VS/S_3-24 and KH-101/S_3-32×VS/S_3-24 showedaverage3-4 baby cobs/plant, high green fodder yield 874-937 g/plant and baby cob picking duration(9-12 days) were selected for further verification.

In set VIII: a Line × Tester analysis was conducted in baby corn involving 6 S_3selected lines and4 testers. The resulting 24 F_1's along with parents and one check 'Baby star' were evaluated in alpha lattice design with two replications at Gazipur. The number of baby cobs/plants contributed maximum for lines, whereas interaction of lines and testers contributed maximum to total variance for baby cobs picking duration.LinesKH-101/S_3-3 and KH-101/S_3-4 have been identified as the best general combiner for baby cobs/plant and baby cobs picking duration. ThreecrossesKH-101/S_3-13×VS/S_3-7, KH-101/S_3-13×VS/S_3-10 and KH101/S_3-25×Vs/S_3-10 were found promising for high fodder yield (0.56 to 1.31kg/plant),early harvesting (85-89 days), average 3 baby cobs/plant and short harvesting duration (10-12 days).

(ii) Evaluation of inbred lines of maize through North Carolina Design II *(4 sets)*

Field corn

In set I: Twenty five field corn hybrids produced through North Carolina Design II (NCD II) involving 5 male and 5 female lines were evaluated in alpha lattice design with two replications at Gazipur. Results showed that non-additive gene action was predominant in controlling the traits. Line 900MG/S_4-4 and testers 9MS/S_6-16 had high mean and positive GCA for grain yield. Four crosses 900MG/S_4-12×9MS/S_6-4, 900MG/S_4-12×9MS/S_6-5, 900MG/S_4-22×9MS/S_6-4 and 900MG/S_4-22×9MS/S_6-16 showed positive SCA with high mean yield (11.33-13.14t/ha) along with minimum lodging damage and low ear height (60-76cm)could be used for hybrid development.

In set II: Twenty five field corn hybrids were produced following North Carolina Design II (NCD II) were evaluated along with parents in alpha lattice design with two replication sat Gazipur. Four lines Pac60/S4-3, Pac60/S4-21, Utn2/S4-15 and BIL113 had positive GCA and higher mean yield. Considering lodging tolerance and higher yield (12.18-13.74 t/ha),five crosses (Pac-60/S4-3×BIL-113, Pac-60/S4-21×BIL-113, Pac-60/S4-9×Utn2/S4-15, Pac-60/S4-21×Utn2/S4-10andPac-60/S4-21×Utn2/S4-15) could be used for hybrid development.

In set III: Twenty five crosses derived from crosses involving 5 female & 5 male parents following North Carolina Design II (NCD II) were evaluated along with the parents in alpha lattice design with two replications at Gazipur. Inbred lines QY11/S_4-14,QY11/S_4-30, 9MS/S_6-10 and 9MS/S_6-15 were good combiner exhibiting significant positive GCA for yield and lodging tolerance ability. Considering lodging tolerance, dwarfness with high yield, 8 crosses (7074/S_3-15×9MS/S_6-10, QY11/S_4-14×9MS/S_6-2, QY11/S_4-14×9MS/S_6-10, QY11/S_4-14×9MS/S_6-14, QY11/S_4-14×9MS/S_6-15, QY11/S_4-30×BIL-113, QY11/S_4-30×9MS/S_6-4 and QY11/S_4-30×9MS/S_6-10) having high yield (13.15-14.80 t/ha) with dwarf plants(161-169cm) and low ear height (61-72cm) could be used for developing lodging tolerance dwarf hybrids with high yield.

Pop corn

In set IV: The study was conducted following North Carolina matting deign II involving 5 female and 5 male lines. The resulting 25 crosses along with the parents were evaluated in alpha lattice design with two replications at Gazipur. The parent lines P622/S_4-33, PCB/S_3-34and PCB/S_3-39 had good GCA for yield and quality traits. Three crosses P622/S_4-14×PCB/S_3-34,P622/S_4-37×PCB/S_3-40 and P622/S_4-39×PCB/S_3-34 showed higher grain yield (4.25-4.99 t/ha) along with the popping quality traits like popping percentage (95-97%), popping expansion (21-30) could be used for hybrid popcorn development.

D: Combining Ability and Heterosis Study

Combing ability and heterosis studies in maize (2 Sets)

In set I: 21 F_1's produced through 7×7 diallel mating design excluding reciprocals were evaluated along with 3 commercial hybrids viz. BHM9, 900MG and NK40 following alpha lattice design with 3 replications in three different environments viz. Gazipur, Jessore and Ishurdi. Among the parents P_5 and $P_7$was found as the best general combiner for high yield; P_1, P_2, P_3 and P_4 for earliness;. and P_2, P_3 and $P_4$for dwarf plant type. The cross $P_5 \times P_7$produced the highest grain yield (13.31 t/ha) as well as the highest heterosis(5.64%),it showed non-significant and but positive SCA effect for the same trait. Six crosses ($P_5 \times P_7$, $P_5 \times P_6$,$P_2 \times P_5$, $P_4 \times P_5$,$P_4 \times P_7$, $P_6 \times P_7$ and $P_1 \times P_5$) showed high mean yield (11.39-13.31 t/ha)could be utilized for developing high yielding hybrids as well as for exploiting hybrid vigour.

In set II*:* 7 inbred lines crossed in a 7×7 diallel mating design excluding reciprocals and the resulting 21crossesalong with 3 commercial hybrids viz. BHM7, NK40 and Pioneer 30V92 were evaluated in alpha lattice design with two replications at Gazipur. Parents P_1 and P_6were good combiner for yield,P_1 and P_3 was good combiner for earliness, P_5 for short plants and P_1, P_4 and P_6 for longer ears, and bold grain. The highest heterosis 13.03% was exhibited by the cross $P_3 \times P_6$ followed by $P_2 \times P_4$ (9.92%). Three crosses $P_3 \times P_6$, $P_2 \times P_4$and $P_5 \times P_6$ showed high mean yield(12.44-13.45 t/ha) as well as higher heterosis(4.54-13.03%) could be utilized for high yielding hybrid variety development.

E: Evaluation of Single Cross, Modified Single Cross &Double Cross Hybrids

(i) Evaluation of single cross maize hybrids (3 Sets)

Field corn

In set I*:* Thirteen locally developed single cross field corn hybrids were evaluated along with two commercial checks 900M and BARI hybrid maize 9 in RCBD with two replications at Gazipur. Three hybrids 9MG/S_4-17×9MS/S_6-4,9MG/S_4-9×Pac60/S_4-19 &9MG/S_4-10×Pac60/S_4-19 showed high mean yield (12.09-13.64 t/ha)along with lodging tolerance were selected for further evaluation at different locations for hybrid variety development.

Baby corn

In set II: Thirty five locally developed single cross baby corn hybrids were evaluated along with a commercial check 'Baby star' in alpha lattice design with 2 replications at Gazipur. Fourteen baby corn hybrids were selected for utilizing high yielding quality hybrid variety development based on number of cobs per plant (4-5 cobs/plant), lower duration of picking baby cob harvesting (7-12 days), green fodder yield (574-909 g/plant) and baby cobs yield without husk(23.2- 39.2 g/plant).

In set III*:* Thirty three locally developed single cross baby corn hybrids were evaluated along with the commercial check 'Baby star' in alpha lattice design with 2 replications at Gazipur. Considering earliness (78-82 days), number of cobs/plant (3.43-3.70) with little bit lower harvesting duration of baby cobs (7.3-13.7 days) 5 crosses KH-101/S_3-28×KH-101/S_3-14, KH-101/S_3-36×KH-101/S_3-31, KH-101/S_3-14×KH-101/S_3-5,KH-101/S_3-17×KH-101/S_3-20 and KH-101/S_3-1×KH-101/S_3-2 were selected for utilizing high yielding quality baby corn hybrids after verification.

(ii) Evaluation of modified single cross hybrid maize ***(5 Sets)***

Field corn

In set I: Twenty five modified single cross field corn hybrids were evaluated in alpha lattice design with two replications at Gazipur to select high yielding desirable hybrids. Three hybrids (9MG/S_3-2×9MG/S_3-4)×Pac60/S_4-19, (9MG/S_3-11×9MG/S_3-3)×900MS/S_6-9 and (9MG/S_3-11×9MG/S_3-6)×Pac60/S_4-19were found promising for high yield (13.3 to 14.8 t/ha), lodging tolerant and medium tall plants could be utilized for hybrid development.

In set II*:* Twenty-two locally developed modified single cross field corn hybrids and a check BARI hybrid maize 9 were evaluated in alpha lattice design with two replications at Gazipur to select high yielding desirable hybrids. Hybrids (Utn-2/S_3-8×Utn-2/S_3-18)×Pac-60/S_4-14 was found promising for grain yield (10.29 t/ha) as well as medium tall for further evaluation.

In set IV: Nine modified single cross hybrids of field corn were evaluated along with two checks 900M and BARI hybrid maize 9 in RCBD with two replications at Gazipur to select high yielding desirable hybrids. Considering overall performances three hybrids (QY11/S_3-1×QY11/S_3-18)×Pac60/S_4-14, (QY11/S_3-8×QY11/S_3-30)×Utn/S_4-16 & (QY11/S_3-24×QY11/S_3-19)×Utn/S_4-8 were found promising for high grain yield (11.53-13.05 t/ha),lodging tolerance and medium tall plants (163-183cm)could be utilized for hybrid development.

In set V: Twenty eight modified single cross hybrids of field corn were evaluated in alpha lattice design with two replications at Gazipur to select desirable high yielding hybrids. Five cross combinations (7074/S_2-8×7074/S_2-5)×Utn/S_4-6, (7074/S_2-11×7074/S_2-8)×Utn/S_4-6,(7074/S_2-14×7074/S_2-6)×Pac60/S_4-21,(7074/S_2-16×7074/S_2-15)×9MG/S_4-12&(7074/S_2-18×7074/S_2-4)×Utn/S_4-6 possessed high mean yields (11.98-14.06 t/ha), lodging tolerance and earliness might be used for obtaining high yielding hybrids.

Baby corn

In set III*:* Twenty three locally developed modified single cross baby corn hybrids were evaluated along with a commercial check ‘Baby star’ in alpha lattice design with two replications at Gazipur to select desirable quality baby corn hybrids. Five modified single cross baby corn hybrids were found promising for higher number of cobs (4 cobs/plant), little bit lower baby cob picking duration (11-13 days), green fodder yield (652-858 g/plant) and baby cob yield/plant without husk (29-33 g/plant) could be selected for further testing.

(iii) Evaluation of double cross maize hybrids at different locations

Sixteen locally developed double cross maize hybrids along with two checksPacific-60 and BARI hybrid maize 9 were evaluated at four location viz. Jessore, Khagrachari, Ishurdi and Joydebpur in RCBD with two replications to select desirable high yielding hybrids. Considering yield potentiality and stability parameters the double cross hybrids A-9 (12.3 t/ha) had high stable yield over all environments. Entry A-10 (12.1 t/ha) was also high yielder with moderate stability. The double cross hybridsA-9 (Pac60/S_3-10×Pac60/S_3-9)×(9MG/S_3-2×9MG/S_3-4) and A-10 (Pac60/S_3-10×Pac60/S_3-9)×(9MG/S_3-3×9MG/S_3-4)could be utilized for development of hybrid after verification.

(iv) Evaluation of promising maize hybrids at different agro-ecological regions of Bangladesh ***(3 Sets)***

In set I*:* Nine locally produced promising selected maize hybrids along with three commercial check variety NK 40, 900MG and BARI hybrid maize 9 were evaluated in RCBD with 3 replication sat seven locations namely Gazipur, Jamalpur, Hathazari, Ishurdi, Rahmatpur, Burirhat and Jessore to assess genotype-environment interaction (GEI) and stability for selection of the best hybrid. Jamalpur, Hathazari, Ishurdi, Rahmatpur, Burirhat, and Jessore were favorable environments for maize production, whereas Gazipur was poor. Among the hybrids, commercial check 900MG showed the highest grain yield (12.50 t/ha) followed by hybrid E7 (12.22 t/ha) and E1 (11.96 t/ha) with stable performance across the locations could be used for hybrid development.

In set II*:* Seven locally produced promising selected hybrids along with three commercial checks, viz. BARI Hybrid Maize 9, NK40 and Pioneer 30V92 were evaluated in RCBD with 3 replications at three locations viz. Gazipur, Rahmatpur and Burirhat to assess GEI and stability for selection of the best hybrid. The environment Gazipur was poor and Barisal and Rangpur were favorable for maize production. The tested hybrid G6 (12.37t/ha) and G7 (12.80 t/ha) produced higher yield withbi~1 and S^2di~0 indicated stability of the hybrids. Considering yield potentiality and stability parameter the hybrids G6 & G7 were found promising across locations could be used for hybrid development.

In set III*:* 8 locally produced promising selected hybrids along with three commercial checks, viz. NK-40, BARI hybrid maize 5andBARI hybrid maize 9 were evaluated in RCBD with 3 replication sat four locations viz. Gazipur, Rahmatpur, Jamalpur and Burirhat to assess GEI and stability for selection of the best hybrid. Gazipur was poor and Jamalpur, Burirhat and Rahmatpur were favorable environments for maize production. The check BARI hybrid maize produced the highest yield (11.75 t/ha).Considering the yield potentiality and stability parameters two hybrids$P_3\times P_7$ (11.31 t/ha)and $P_4\times P_6$ (10.09 t/ha)were found promising and stable across the environments could be used for hybrid development.

F: Adaptive Trials

Adaptive trial with promising maize hybrids at different locations followed by potato cultivation

Fifteen hybrids along with one commercial check 900M were evaluated at four locations viz.Thakurgaon, Debigonj ,Rangpur and Munshigonj during Kharif 1 just after potato harvesting in RCBD with 3 replications applying with (1) and without (2) fertilizer to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. The same materials were evaluated in two sets at every location following in set I fertilizers application @ 120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K. S, Zn and B, respectively and in set II, only 1/3rd of urea the above mentioned fertilizers were applied at knee high stage of the crop. Seeds were sown on 18, 19, 20 & 24 March 2014 at Rangpur, Debigonj, Thakurgaon and Munshigonj, respectively. The environment Thakurgaon2 and Debigoaj2 were poor (without fertilizer) but Debigonj1 and Rangpur1 (with fertilizer) was most favorable for maize production after potato cultivation. Among the locations, Rangpur was found highly suitable for maize cultivation in the kharif after potato cultivation. The hybrids E7 (8.28 t/ha) and E13 (8.51 t/ha) produced high yield and also showed stable across eight environments and selected and could be used for cultivation after potato harvesting. However, the experiment needs to be repeated for further confirmation.

Demonstration trials of BARI maize hybrids in Rangpur, Kurigram, Nilphamari and Lalmonirhat under IAPP

Two BARI maize hybrids viz. BARI hybrid maize 7 and BARI hybrid maize 9 were demonstrated in different farmer’s field at Rangpur, Kurigram, Nilphamari and Lalmonirhat districts under IAPP project to show the performance of BARI maize hybrids and recommended technologies and also to popularize the varieties to the farmers in these areas during rabi 2014-15.There were 4 types demonstrations based on land area in the above districts in which 40 demo conducted each with 40 decimal land with BHM 9; 16 demo each with 50 decimal blocks with BHM 7; and rest 8 demo each with 100 decimals large block with BHM 9. Equally the demonstrations were distributed and planted in 4 districts. Overall average grain yield of BARI hybrid maize 9 ranged from 7.3 to 9.2 t/ha in these trials. Among the four districts, the highest average grain yield (9.05 t/ha) was obtained in Rangpur. The higher average yield (8. 47 t/ha) was obtained from BARI hybrid maize 9 followed by BHM

7(8.24 t/ha), it was identical with the farmer's cultivated variety NK 40 (7.78 t/ha) and Sunshine (7.24 t/.ha). Farmer's are interested to cultivate BARI maize hybrids, but seeds are not available at farmer level during sowing time.

G: Collaborative Program

Comparative yield trial of imported and local maize hybrids

Twenty four exotic hybrids imported by different companies, five locally produced selected experimental hybrids along with three BARI maize hybrids were evaluated in alpha lattice design with 3 replications at six locations viz. Gazipur, Rangpur, Jamalpur, Barisal, Ishurdi and Hathazari to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. The environment Gazipur, Ishurdi and Jamalpur showed poorer, but Rangpur was found highly suitable for hybrid maize cultivation followed by Barisal and Hathazari. Considering the mean performance, bi and S^2di all the hybrids showed different response of adaptability under different environmental conditions. Among the hybrids IM 8119 (12.48 t/ha), Elite (11.74t/ha), IM 8013 (11.69t/ha), Titan (11.25t/ha), 9120 (11.83t/ha), VA Shaktiman (10.74 t/ha) and BHM 9 (10.78 t/ha) exhibited high and stable yield over all environments.

H: Maize Biotechnology

Modulation of oxidative damage by polyamine in maize seedlings under polyethylene glycol induced drought stress

In order to investigate the protective role of polyamines (PAs) in maize under drought stress, maize seedlings (*Zea mays*cv Khoib hutta) were imposed to 20% polyethyleneglycol (PEG) containing 50 μM of putrescine (Put), spermidine (Spd) and spermine (Spm) for 48 hours and the contents of relative water content (RWC), proline, chlorophyll and malondialdehyde (MDA), hydrogen peroxide (H_2O_2), rate of superoxide radicals ($O_2^{\bullet -}$) generation and methyl glyoxal (MG) and the antioxidant enzyme activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), ascorbate peroxidase (APX), glutathione reductase (GR), monodehydroascorbatereductase (MDHAR), dehydroascorbatereductase (DHAR), glutathione *S*-transferase (GST), glyoxalase I (Gly-I), glyoxalase II (Gly-II) and lipoxigenase (LOX) were checked. Treatment of Put, Spd and Spm effectively maintained the balance of water content and chlorophyll contents in leaves. In addition, the data indicated that the pretreatments reduced accumulation of the proline suggesting the reduction of stress effect. They also decreased H_2O_2 content, rate of $O_2^{\bullet -}$ generation, and prevented drought induced MDA. The activities of CAT, APX and GPX were found to increase in response to put. Treatment of Put, Spd and Spm increased MDHAR activity, contrary they reduced LOX activities remarkably. Therefore, the antioxidant can be changed by PAs, which are able to modulate the radical scavenging system and to lessen in this way the oxidative stress. The results suggest that pretreatment with Put, Spd and Spm prevents oxidative damage, and the protective effect of Put was found to be greater than that of Spd and Spm.

Purification of glyoxalase-I from maize

Since Glyoxalase-I (Gly-I) is important detoxifier of methyl glyoxal (MG), this study was designed to examine the level of Gly-I in maize and to purify it from maize seedlings. Both green and non-green part of maizeseedlings were used to purify. Crude proteins were precipitated by 65% $(NH_4)_2SO_4$, and dialyzed over night. The dialyzate was applied on DEAE-cellulose chromatography and eluted with linear grade of KCl from 0 to 0.2 M. In both cases, Gly-I eluted at approximately 85 mM of KCL. The active Gly-I fractions were pooled and applied on affinity chromatography (*S*-hexyl glutathione-agarose) and eluted with 1.2 mm of *S*-hexyl glutathione. The purified protein from green and non-green part had specific activity of 33.23 and 29.25 μmol min^{-1} mg^{-1}protein, respectively along with recovery of 1.47 and 162, respectively and yield of 83.11 and 68.15, respectively. In SDS-PAGE, the active purified affinity fraction was found to move with another protein. The spectrophotometric analysis showed the Gly-I protein elutes with GST protein.

I: Stress Breeding

Evaluation of inbred lines of excess sold moisture tolerant maize through line × tester method

Thirteen inbred lines were crossed with 2 testers in Line ×Tester matting design and the resulting 26 crosses along with the parents were evaluated in alpha lattice design with two replications under excess soil moisture (ESM) condition at Jamalpur to identify ESM tolerant genotypes. Irrigation was applied at knee high stage with a ponding depth of12-15 cm continuously for 10 days. Parents with good gca for grain yield BMZ 6, BMZ 15, BMZ 66, BIL 182 & CML 116; for earliness BMZ 22 and for dwarfness BIL 26 may be used in hybridization program as donors. Better performing three crosses BMZ 22×CML 425, BMZ 66×CML 425 and Ki 21×CML 425 showed considerable mean yield (4.66-5.47 t/ha)and also had significant positive sca for yield were selected for further verification.

Adaptive trials with low water required white grain hybrid maize in high barind tract

Eight selected white grained hybrid maize including two checks were evaluated in RCBD dispersed replication in the farmers' field of 4 villages of Godagari upazila under Rajshahi district in high barind tract during Rabi 2014-15 to test the performance of locally developed selected promising low water required white grained hybrid maize for selecting medium height best one(s) for Barind areas. In each location all the entries were cultivated in two different sets- irrigated and non-irrigated (only single irrigation applied before flowering stage) condition. The dwarf plant and low ear height observed in the hybrids Q_1×Q_2 and P_1×P_2, were significantly shorter than the checks Suvra and Zimbabwe, which also showed susceptible to lodging. There was no significant yield difference in the genotypes between irrigated and non-irrigated conditions. The numerically higher yields in low-irrigated condition obtained from the hybridsP_2×P_5(7.84 & 8.45 t/ha),P_1×P_2(8.03 & 8.36 t/ha) and P_1×P_4(8.19 & 8.45 t/ha) in both irrigation regimes. At maturity stage, P_2×$P_5$was remained green and also showed tolerance to lodging. Considering overall performances, the hybrids P_1×$P_4$and P_2×P_5could be used as hybrid maize variety for barind areas. Farmers were enthusastic about white maize. They were very happy and highly interested about some of the hybrids performed better in low-irrigated condition.

Selection criteria, evaluation and associated genomic regions for low-p stress tolerance in maize

Phosphorus (P) is the 2nd most important macro-element that is essential for plant growth and development. A total of 25 maize germplasm were evaluated for seedling traits in hydroponic under low phosphors (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. The first two principal components (PCs) explained about 91.13% of the total variation among lines for the eight traits in maize seedling. The relative magnitudes of eigenvectors 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. Genotype×traits (G×T) biplot revealed superior genotypes with combinations of favorable traits. 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. 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. Substantial genetic variation in P efficiency exists among the genotypes and a number of QTLs controlling traits for P efficiency have been identified in maize, and precision phenotyping will contribute to develop maize varieties tolerant to LP stress.

Screening of inbred lines of maize against salinity stress under field condition

The experiment composed of 85 local and CIMMYT maize inbred lines were evaluated following alpha lattice design with two replications at Banerpota, Satkhira to find out suitable salt tolerant inbred lines. Seeds were sown in Kharif season on 2nd March 2015. Variations were observed for kernel yield and other traits studied. The inbred line I-63 (3.38 t/ha) & I-5 (3.14 t/ha) performed best among the studied lines. Considering yield and other contributing traits 7maize inbred lines I-4, I-5, I-34, I-37, I-38, I-60 and I-63 were found suitable and better under salinity stress (11 dS/m2)at field condition could be utilized for saline tolerant hybrid development.

Screening of hybrid maize against salinity stress under field condition

The experiment was conducted with 80 locally developed maize hybrids evaluated at Banerpota, Satkhirain alpha lattice design to find out suitable salt tolerant hybrids. Seeds of all the hybrids were sown in Kharif season on 1st March 2015. The variations were observed for yield other traits. The crosses H-58 (5.69 t/ha) and H-75 (4.65 t ha^{-1}) were the best among all the crosses. Considering kernel yield, yield contributing traits and overall field performances and tolerance under salinity stress (11 dS/m2) the15 hybrids viz. H-35, H-37, H-42, H-43, H-49, H-52, H-58, H-61, H-62, H-66, H-72, H-73, H-74, H-75 and H-79 were found promising and suitable and needs for further investigations in the salinity stress prone areas.

J: Nutritional Maize Development

Study of combining ability in white grain quality protein maize

Eight white grained quality protein maize (QPM) inbred lines were mated in all possible combinations (excluding reciprocals) and the resulting 21 F_1's and along with four checks BARI hybrid maize 5, BARI hybrid maize 7, BARI hybrid maize 9 and 900Minalpha lattice design with two replications at Gazipur to select desirable best one(s).The parental lines P_4, P_7 & Q_6 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 highly significant positive SCA crosses $Q_5 \times P_7$, $P_7 \times Q_6$&$P_7 \times Q_2$possessed high mean yield (13.79-14.53 t/ha) along with medium lodging tolerance could be utilized in variety development after verifying them in different locations.

Evaluation of quality protein maize test cross hybrids

Sixteen locally developed quality protein maize test cross hybrids were evaluated along with two checks BARI hybrid maize-5 and 900M and in alpha lattice design at Gazipur to select high yielding desirable best one(s).Considering yield, plant & ear height and overall performances two hybrids $W_1 \times W_7$ (13.06 t/ha) and $W_3 \times W_7$ (12.41 t/ha) were found promising and could be utilized in variety development after verifying them in across locations.

K: Maintenance&Seed Increase of Parent Lines, Hybrids and OPVs

Maintenance and seed production of the parental lines of BARI maize hybrids

Purity of the parent lines is very important for a hybrid variety of maize. Total 32 kg seeds of 9parent lines (BIL-20,BIL-22, BIL-28, BIL-79, BIL-106, BIL-110, BIL-113, BIL-114 &BML-36)of different BARI maize hybridsand few other inbreds were obtained by selfing and stored for use in the next rabi season.

Total 5350 kg breeder's seedof9 parental lines (BIL-20, BIL-22, P-1, P-7, BIL-28, BIL-79, BIL-106, BIL-110 and BIL-114)of different BARI maize hybrids were produced in different locations maintaining proper isolation during rabi 2014-15 and stored. This seed will be provided to BADC and seed companies for hybrid seed production in the next year.

Hybrid seed production of BARI hybrid maize varieties

Hybrid seed is one the prime factors for increasing area and production of maize in the country. Total 4295 kg hybrid seed of three BARI maize hybrids viz. BARI hybrid maize-5, BARI hybrid maize-7 and BARI hybrid maize-9 were produced at different stations 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

Total990 kg breeder's seeds of 4BARIopen-pollinated maize varieties (Barnal, Shuvra, BARI maize-7 &BARI Khoibhutta-1) were produced at different location in isolation condition maintaining female and male ratio of 2:1. At flowering 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 use.

L: CIMMYT & HTMA Program

CIMMYT Trials:

Evaluation of CIMMYT yellow and white maize hybrids in different agro-ecological regions (3 Sets)

In set I*:* 60 CIMMYT yellow grained hybrid maize along with four commercial checks NK 40, 900MGold, 981 and BARI hybrid maize 9were evaluated in alpha lattice with 2 replications at five locations viz. Gazipur, Ishurdi, Barisal, Jessore and Jamalpur to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. Gazipur, Ishurdi and Jamalpur were poor and Rahmatpur and Jessore were favorable environments for hybrid maize production. Considering the average yield potentiality and stability parameter, four hybrids E3 (12.22 t/ha), E33 (12.48 t/ha), E39 (11.71 t/ha) and E60 (11.41 t/ha)were found promising across locations.

In set II*:* Twelve CIMMYT yellow grained hybrid maize along with two local checks (BARI hybrid maize 7 and BARI hybrid maize 9) were evaluated in RCBD with three replications at two locations viz. Gazipur and Rangpur. Sowing was done on 19 and 20 June 2014 at Gazipur and Burirhat, respectively. Entry-1 (8.23 t/ha), entry-5 (8.07 t/ha) and entry-8 (7.87 t/ha) produced higher grain yield in both the locations than the check BARI hybrid maize 9 (7.46 t/ha) and need to be verified.

In set III: Thirteen CIMMYT white grained hybrid maize were evaluated along with two local checks (BARI hybrid maize-7 and BARI hybrid maize-9) in RCBD with three replications at three locations viz. Gazipur, Jessore and Jamalpur during kharif-2 season 2014. The hybrids E-1 (7.85 t/ha), E-10(6.39 t/ha) and E-13(6.47 t/ha) showed stable yield across location and need to be further evaluated.

HTMA Trials:

Phenotyping of the test cross hybridmaize under heat stress trials at Jessore *(11sets)*

The experiment composed of 11 sets of HTMA trials and a total of 1177 test cross maize hybrids from CIMMYT, India were evaluated along with eight commercial check varieties following alpha lattice design at the RARS, Jessore during the kharif-1 season of 2014 to observe the performance of the hybrids under heat stress condition. Among the tested hybrids, considering yield and other contributing traits including heat stress tolerance the best hybrids were ZH111948 (10.72 t ha^{-1}), E25 (11.17 t/ha), E27 (10.60 t/ha), ZH132660 (10.28 t/ha), ZH132549 (10.74 t/ha), ZH132461 (10.31 t/ha), E1 (9.03 t/ha), E19 (9.63 t/ha), ZH135836 (9.41 t/ha)were selected and need to be further evaluated.

Phenotyping of the test cross hybrid maize under heat stress trials at Ishurdi*(10 Sets)*

A total of 1435 test cross maize hybrids from CIMMTY, India including eight checks were evaluated in 10 sets of trials under HTMA project at the RARS, Ishurdi during kharif-1 season of 2014following alpha lattice design to evaluate the performance of test cross hybrids under heat stress condition. Among the tested hybridsZH1316 (9.63 t/ha), ZH111656 (8.19t/ha), VH101429 (7.10 t/ha) and

ZH138389 (7.74 t/ha), E-48(6.73 t/ha), E-50(6.01t/ha), E-37(6.35 t/ha), ZH133655 (6.71 t/ha), ZH133706 (5.95 t/ha), E5 (5.95 t/ha), E75 (5.95t/ha), E4 (5.98 t/ha) produced higher yield & selected to verify them in across ecologies.

Phenotyping of the test cross hybrids under optimal temperature at Gazipur (4 Sets)

A total of 710 test cross maize hybrids from CIMMYT, India were evaluated under HTMA project including six commercial checks were studied at Gazipur during the kharif-1 season of 2014following alpha lattice design to test the performance of the hybrids under optimal condition. Among the tested hybrids considering yield and other characters the following hybrids ZH11379 (6.07 t/ha), ZH138384 (5.09 t/ha), ZH11316 (7.69 t/ha), ZH111948 (7.11 t/ha),E-35 (9.00 t/ha), E-37 (8.90 t/ha),E-16 (8.67 t/ha),E-132 (9.86 t/ha), E-126 (9.70 t/ha),E-81 (9.59 t/ha),E-45 (10.23 t/ha), E-135 (10.10 t/ha),E-62 (10.07 t/ha),E-47 (8.32 t/ha), ZH138151 (9.62 t/ha), ZH138207 (9.58 t/ha), ZH138204 (9.35 t/ha), E-50 (8.78 t/ha), E-44 (8.38 t/ha) and E-89 (8.30 t/ha) were selected for farther evaluation in optimal temperature across agro-ecologies.

Phenotyping of the test cross hybrids under optimal temperature at Barisal (4 Sets)

A total of 608 CIMMYT, India developed test cross hybrids along with five checks were evaluated following alpha lattice design under HTMA project at Rahmatpur, Barisal during kharif 2014 to observe the performance of the hybrids normal temperature. Considering yield and other traits the entries ZH132497 (9.98 t/ha), ZH132454 (8.86 t/ha), ZH132450 (11.49 t/ha), ZH132650 (9.94 t/ha), ZH132745(9.91 t/ha), ZH135650 (10.54 t/ha),ZH132629(10.51 t/ha), ZH135791(10.63 t/ha), ZH135860(10.57 t/ha) and ZH135792(10.52 t/ha)were selected for further evaluation.

Demonstration trial of selected HTMA hybrids at different agro ecological condition

A total of 24 selected heat tolerant CIMMYT maize hybrids and six commercial hybrids used as checks (900MG, 981, NK 40, Pioneer30V92, BHM-7 and BHM-9) were evaluated in four locations viz.Gazipur, Rahmatpur, Jessore and Burirhat to test and observe the performance of the hybrids across environments. Among the entries two yellow grained hybrid HTMA 19(12.44 t/ha) and HTMA 22(12.75 t/ha) out yielded the best check variety 981(12.41 t/ha) and were also ranked top among the tested hybrids by the participants (private seed company people, BADC and others) selected during field day at Jessore, Rahmatpur and Burirhat. HTMA 21(11.97 t/ha) a white grained hybrid also out yielded the rest five checks. Another white grained hybrid HTMA 14 (10.84 t/ha) 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 21and HTMA 22 were found promising and hence, they could be selected for commercial cultivation across ecologies in Bangladesh.

M. Technology Transfer Activities

During 2014-15, the Plant Breeding Division of BARI arranged eleven Training Program (Conference/Refresher Course/Training- for scientists, field & office staffs, farmers) and four field days for dissemination of technologies.

Crop: Barley Millets and Sorghum

Confirmation of F_1 Generation of Barley

Based on phenotypic expression of hybrids with their respective female parents 5 F_1 . population were confirmed as hybrids and evaluated this year successfully.

Evaluation and Selection of barley in Different Filial Generation

Selected Bulk method was followed during selection in different segregating generation. Selection was done based on earliness, short stature, hull-lessness and high yield. In F_2 generation 31 single plants from 11 crosses, in F_3 generation 11 families out of 16, in F_4 generation 6 families out of 3, in F_5 generation 8 families out of 13 and in F_6 generation 3 families out of 3 were selected for generation advance.

Preliminary, Advance and Regional Yield Trial of Barley

Seven barley lines including check variety BB6 were evaluated in preliminary yield trial at BARI, Joydebpur, during rabi season 2014-15. Considering plant height, yield and yield contributing characters 3 lines such as E-24 (2.0 t/ha), BHL-10 x BB-5 (3.1t/ha) and E-21 (2.2 t/ha) were selected for next year trial.

Combined analysis was carried out with five lines including check BB-6 across 3 different locations Gazipur, Rahmatpur and Ishwardi, during rabi (2014-2015) to find out the suitable genotypes for next year yield trial. Analysis of variance showed the presence of genetic variabilities among the lines. From the overall mean yield and other desirable characters two entries viz. BHL-21(1.94 t/ha) and 6-B-952482 (1.88 t/ha) were found suitable across location.

Combined analysis was carried out with four advanced lines including check BB-6 across 2 different locations Gazipur and Ishurdi, during rabi (2014-2015) to find out the suitable high yielding genotypes. Analysis of variance showed the presence of genetic variability among lines. From the overall mean yield and other desirable characters two entries viz Ager/12 (1.93 t/ha) and Esmarelda (1.8 t/ha) were found suitable across location.

Evaluation of barley varieties for duel purpose (grain & fodder)

Six BARI barley varieties were evaluated for duel purpose use (grain and fodder) at BARI, Gazipur, during rabi season 2014-15.For using as fodder leaves of barley plants were cut at 40 days after sowing at 10cm height from soil level. Considering fodder production and as well as grain yield two BARI barley varieties viz. BARI Barley 5 (grain and fodder yield 1.4 t/ha and 10.1t/ha respectively) & BARI Barley 6 (grain and fodder yield 1.5 t/ha and 11.2 t/ha respectively) were selected for duel purpose use.

ICARDA International trials

Twenty four ICARDA hulled barley genotypes were evaluated along with check BARI Barley 5 under high input condition at BARI, Gazipur, during rabi 2014-2015 to find out the suitable genotypes. The genotypes differed significantly for different traits except length of spikes. Among the genotypes, entry 10 and 20 had minimum days to maturity (99 days), the trait most desirable one. Entry 6 (3.5 t/ha) exhibited the highest yield followed by entry 7 (2.9 t/ha) which is significantly higher than the check variety (2.31 t/ha).

Twenty four ICARDA hull-less barley genotypes were evaluated along with the check BARI Barley 6 at BARI, Gazipur, during rabi 2014-2015 to find out the suitable genotypes. The genotypes differed significantly for different traits except days to maturity and 1000-grain weight. Among the genotypes, entry 4 took minimum days to maturity (99 days), the trait most desirable one. Entry 5 (3.05 t/ha) exhibited the highest yield followed by entry 9(2.75 ton/ha) and entry 13 (2.75 ton/ha) which is significantly higher than the check variety (1.95 t/ha).

The experiment observation nursery of ICARDA hulled barley were conducted with 159 lines along with check BARI Barley at BARI, Gazipur, during rabi season 2014-15to select better performing lines. Considering earliness (89-99 days), yield and yield contributing characters 16 lines produced higher yield (6.0–10.4 g/plant) than the check variety (4.6g/plant) were selected for preliminary yield trial

Seventy eight ICARDA hulls-less barley lines were evaluated in observation nursery at Gazipur during rabi season 2014-15to select better performing hull-less barley lines. Considering yield and yield contributing characters 16lines which gave higher yield (7.2-8.2 g/plant) than the check variety (6.6 g/plant) were selected for preliminary yield trial.

Breeder Seed Production of Barley and Millets

Seeds of seven barley varieties were increased to maintain the purity of the released varieties and for distributing to BADC and other agencies and farmers. A total of 367 kg of breeder seed of 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 three different locations viz. Gazipur, Ishurdi and Burirhat.

Breeder seed is essential for maintaining purity of the variety. A total of 181 kg breeder seed of three Kaon varieties viz. BARI Kaon 1, BARI Kaon 2, & BARI Kaon 3 and one Cheena variety (BARI cheena 1) were produced at three locations (Gazipur.Ishurdi and Burirhat).

Seed Increase of Selected Finger millets, Foxtail millets, Pearl millets &Sorghum Germplasm

Quality seeds of the selected 19 finger millets germplasm were in creased at BARI, Joydebpur, during rabi season 2014-15. Total 14.45 kg seeds were produced for next year trial.

Seeds of 8 selected foxtail millets germplasm were increased at BARI, Joydebpur, during rabi season 2014-15. Total 3.2 kg seeds were produced for next year trial.

Quality seeds of 9 selected pearl millets germplasm were increased at BARI, Joydebpur, during rabi season 2014-15. Total 3.97 kg seeds were produced for next year trial.

Seeds of 9 selected sorghum germplasm were increased at BARI, Joydebpur, during rabi season 2014-15. Total 9.30 kg seeds were produced for next year trial.

2 TUBER CROPS

Potato

Varietal Development

Hybridization in Potato

Hybridization was done at Debigonj and Joydebpur using 168 and 193 genotypes/varieties, respectively under 16 hours extended photoperiod to create variability, and for the selection of desirable genotypes. At Joydebpur, 280 out of 630 crosses and at Debigonj, 546 out of 1061 crosses produced berries. In total 340 g hybrid seeds were produced of which 120 g was at Joydebpur and rest at Debigonj.

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

Hybrid seeds which were produced in 2013-14 at Gazipur and Debiganj were sowed at Breeder Seed Production Centre, Debiganj on seedbed. Out of 775 crosses 675 were germinated. A total of 262 single plants were selected from total population.The harvested selected plants weighing 80 kg stored for next year observation.

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

During selection planted potato clones are subjected to selection as single plant, plant row and single plot in subsequent clonal generations. In F_1C_1, F_1C_2 and F_1C_3 generations 51 potato clones weighing 400 kg were selected and stored at BSPC, Debigonj for further evaluation.

Table-1. Clonal potato hybrid selection in different generations, 2014-2015 at BSPC.

Generation planted	No./Quantity planted	Number of Selection plants	Selected Tubers weight (kg)
F_1C_1	107(ST) kg	24 SP	60
F_1C_2	162SP(117kg)	12 plant rows	80
F_1C_3	26plant rows	15 single plot	260
Total tuber weight			400

*ST= Single Tuber **SP= Single Plant

Preliminary yield trial with clonal potato hybrids (F_1C_4)

Performance of 10 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 13 genotypes 12.22 gave the highest yield (61.03 t/ha) and followed by 12.7 (60.90 t/ha), 12.13 (56.42 t/ha), 12.8 (53.51 t/ha), 12.27 (51.88 t/ha), 12.28 (50.83 t/ha) and the lowest was found in 12.20 (25.46 t/ha). Among the genotypes 6 hybrid clones gave more yield over check variety.

Secondary yield trial with clonal potato hybrids (F_1C_5)

Performance of 10 hybrid clones of potato was evaluated with check variety BARI Alu-7 (Diamant), BARI Alu-25(Asterix) and BARI Alu-28(Lady-Rosetta) in Joydebpur, Debigonj and Jamalpur, respectively. Significant yield variation was observed among the clonal hybrids from location to location as well as within location. At Joydebpur, among the ten hybrid clone, hybrid clone 11.88 produced the highest significant yield (37.36 t/ha) at harvest followed by the hybrid clone 11.95 (35.75 t/ha), 11.93 (33.01 t/ha), 11.68 (31.02 t/ha) and 11.105 (30.00 t/ha). At Jamalpur among the eight hybrid clone, hybrid clone hybrid clone 11.50 produced the highest significant yield (53.54 t/ha) followed by hybrid clone 11.80 (49.81 t/ha) and 11.88 (47.37 t/ha). At Debigonj, hybrid clone 11.95 produced the highest significant yield (48.11 t/ha) followed by hybrid clone 11.50 (45.69 t/ha), 11.88 (45.49 t/ha), 11.93 (45.33 t/ha), 11.68 (44.97 t/ha) and 11.80 (44.90 t/ha). From three locations 11.88 was the promising clone. The lowest yield, 26.74 and 32.40 t/ha was found in check BARI Alu-7 (Diamant) (16.81t/ha) and BARI Alu-28 (26.74 and 32.40 t/ha) from Joydebpur, Jamalpur and Debigonj, respectively. On an average, highest yield found by 11.88 (43.41 t/ha) followed by 11.95 (41.93 t/ha), 11.50 (41.87 t/ha), 11.80 (40.85 t/ha) and 11.93 (40.32 t/ha). All the genotypes produced more yield over check variety. Therefore considering all the characters these hybrid clones except 11.35 could be selected for further evaluation under AYT experiment.

Advanced yield trial with clonal hybrids (F_1C_6)

Nine clonal hybrids of potato were evaluated at six locations during 2014-15 for third generation. Clone 10.59 gave significantly the highest yield (29.03 t/ha) at 65 DAP. Clone 10.59 and 10.58 can be selected for commercial cultivation due to its higher tuber yield potentiality as early bulker. Clone 10.116 gave the statistically highest yield (60.88 t/ha) in Jessore at harvest. Considering the average of six locations clone 10.116 also gave the significantly highest yield (44.81 t/ha) which was identical to clone 10.58 (44.01 t/ha), whereas the lowest tuber yield (27.71 t/ha) was with check BARI Alu-28 (Lady Rosetta). Dry matter percentage at harvest was the highest with clone 10.245 at Jessore. Considering the average over locations, here check BARI Alu-28 (Lady Rosetta) again gave the statistically highest percentage of dry matter (20.33). Clone 10.105 gave more large (>55mm dia) size tubers which made great contribution towards percentage of tuber number and tuber weight. Seed tuber grade percentage was satisfactory performance among the genotypes and over the locations. Nine tested genotypes were mature between 80 to 95 days but four clones were different and that were late mature. Clone 10.245, 10.116 and 10.58 performed better than check regarding taste, appearance and texture of boiled potato. Clone 10.58 and 10.245 can be selected as processing varieties due to its high processing qualities. Finally clone 10.245, 10.116 and 10.58 can be selected for RYT on the basis of field performance and organolaptic taste.

Table-2. Tuber yield at harvest of selected genotypes as influenced by different environments of potato, 2014-15.

Genotypes\location	Bogra	Debigonj	Gazipur	Jamalpur	Jessore	Munshigonj	Mean
10.3	24.86	54.37	38.57	41.89	42.31	36.83	39.81 c
10.35	26.16	49.44	40.59	38.34	52.96	38.80	41.05 bc
10.58	28.30	57.12	42.06	44.60	55.92	36.05	44.01 a
10.59	24.93	51.71	38.45	43.33	59.08	39.10	42.77 ab
10.90	28.74	50.43	35.65	39.20	48.84	42.13	40.83 bc
10.105	29.56	54.08	33.43	41.94	56.90	37.77	42.28abc
10.116	25.39	57.40	36.09	48.71	60.88	40.37	44.81 a
10.245	22.58	43.15	31.15	33.70	46.16	37.43	35.69 d
10.275	22.56	60.86	32.66	40.13	45.46	41.40	40.51 bc
Diamant	16.96	44.55	29.33	29.62	36.48	32.30	31.54 e
Asterix	20.62	43.46	25.84	33.41	39.54	29.97	32.14e
L.Rosetta	21.17	37.59	21.12	24.87	31.76	29.77	27.71f
LSD value						6.347	2.591

Regional yield trial of clonal hybrids of potato

Two clonal hybrid of potato namely 9.112 and 9.125 along with check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated at six different agro ecological environment/locations during 2014-15 cropping season 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 potato. The clonal hybrid 9.125 yielded the highest (23.16 t/ha) followed by 9.112 (22.10 t/ha) and BARI Alu-7 (21.69 t/ha) at 65 DAP. At 95 DAP all hybrid clones yielded higher than the all check varieties in case of genotype means over locations. Both the hybrid clones are suitable for pertial commercial processingand found promising. So, considering the yield in farmers' field trial, post-harvest, processing, disease and insect data both clonal hybrids were recommended for the release as commercial variety (s).

Table 3. Interaction effect of genotype and location and genotype mean over location under RYT 2014-15.

Variety/ Hybrid clone	Tuber yield (t/ha) at 95 DAP						
	Joy	Jam	Mun	Jes	Bog	Deb	Mean
9.112	35.78 h-l	40.55 d-h	48.90 bc	42.82 def	37.81 f-j	56.32 a	43.70 a
9.125	32.30 k-n	45.41 cd	50.77 b	44.95 cd	34.62 j-m	51.67 b	43.29 a
BARI Alu-7 (Diamant)	28.34 n	35.05 i-l	38.73 e-j	32.08 lmn	28.20 n	43.38 de	34.30 b
BARI Alu-25 (Asterix)	29.89 mn	34.46 j-m	41.90 d-g	34.11 j-m	21.50 o	45.09 cd	34.49 b
BARI Alu-28 (L.Rosetta)	22.73 o	37.39 g-k	36.77 h-l	22.50 o	27.93 n	39.86 e-i	31.20 c
CV(%)							
F-test	**						**
Variety/ Hybrid clone	Dry matter (%) at 95 DAP						
	Joy	Jam	Mun	Jes	Bog	Deb	Mean
9.112	19.97 hij	17.33 l	19.16 jk	20.80 e-h	20.29 f-i	17.86 l	19.24 d
9.125	20.25 f-i	14.67 m	18.85 k	21.80 bcd	21.82 bcd	17.92 l	19.22 d
BARI Alu-7 (Diamant)	20.92 d-h	20.33 f-i	21.17 c-f	20.50 e-i	21.00 d-g	18.94 k	20.48 b
BARI Alu-25 (Asterix)	19.70 ijk	17.00 l	21.16 c-f	20.07 g-j	22.00 bc	17.90 l	19.64 c
BARI Alu-28 (L.Rosetta)	20.37 f-i	20.00 hij	21.44 cde	22.93 a	22.67 ab	20.18 f-i	21.27 a
CV(%)	2.57						
F-test	**						**

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

Participatory variety selection of clonal hybrids

The selected clonal hybrids with check varieties were evaluated at farmer's field under participatory variety selection to understand the performance as well as farmers opinion. On the average of six locations, both the tested hybrid clones produced higher yield than check varieties. The highest tuber yield 36.66 t/ha was recorded in 9.112 followed by 9.125 (35.70 t/ha), BARI Alu-25 (Asterix) (29.48 t/ha) and BARI Alu-7 (Diamant) (29.32 t/ha). The lowest yield (27.94 t/ha) was recorded in BARI Alu-28 (Lady Rosetta). Most of the farmers were very much interested for both the clonal hybrids 9.112 and 9.125 for their size, shape, color but varied location to location.

Table 4. Performance of clonal hybrids of potato for tuber yield under PVS at 95 DAP in farmers' fields.

Hybrid clone/Variety	Tuber Yield (t/ha) at 95 DAP						
	Joy	Jam	Mun	Jes	Bog	Debi	Mean
9.112	37.93	29.16	43.33	38.10	39.37	32.09	36.66
9.125	30.64	31.25	41.55	43.07	41.51	26.19	35.70
BARI Alu-7 (Diamant)	27.75	32.63	30.55	30.27	32.84	19.63	29.32
BARI Alu-25 (Asterix)	33.33	29.86	27.36	31.53	28.58	26.24	29.48
BARI Alu-28 (L.Rosetta)	29.91	27.77	31.25	23.37	31.11	24.20	27.94

Introduction and selection of exotic varieties

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

Sixteen potato (Solanum tuberosum L.) genotypes including three checks in randomized complete block design with three replications at Joydebpur, Jamalpur, Munshigonj, Jessore, Bogra and Debigonj were evaluated in rabi 2014-15. The genotypes were evaluated for yield and yield components with objectives to estimate the nature and magnitude of GEI for tuber yield and to identify stable potato genotypes for general adaptation and unstable genotypes for specific adaptation. Combined analysis of variance showed highly significant difference between the genotypes, locations and GEI for all the characters studied. The highest tuber yield 61.20 t/ha was recorded in 7 four 7 at Debigonj. This genotype also showed highest average yield (39.20 t/ha) all over the Bangladesh which was statistically similar with Farida (38.31 t/ha) and Cimega (37.48 t/ha). The genotype Granada gave lowest significant tuber yield (8.63 t/ha) at Munshigonj. This genotype also showed lowest average yield (17.30 t/ha) all over the Bangladesh. All the exotic varieties showed satisfactory yield as first year trial except Granada. Considering the overall yield and other characters all the genotypes may be selected for further evaluation in the next year.

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

Six exotic varieties viz. Bafana, Camel, Figaro, Forza, , Verdi and Yukon Gem along with three check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (L. Rosetta) were evaluated at six different agro ecological locations (Debigonj, Joydebpur, Bogra, Munshigonj,Jamalpur and Jessore) during 2014-15 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 Camel produced the highest yield (52.52 t/ha) at Debigonj location. The highest dry matter percentage was found in Verdi (22.27 %) at Jessore location. Considering the overall yield and other characters further evaluation in the next year should be needed of those exotic varieties for more confirmation.

Advanced yield trial with exotic potato varieties for table and proscessing purposes

Ten exotic varieties were evaluated at six locations during 2014-15 for third generation. Barcelona gave the significantly highest yield (27.13 t/ha and 43.3 t/ha) at 65 DAP and final harvest. Across the locations, dry matter percentage at final harvest was the highest (23.39) with check BARI Alu-28 (Lady Rosetta) at Jamalpur which was similar to that of the same check at Bogra (22.72), Jessore (23.03) and Gazipur (20.02). Considering the average over locations, here check BARI Alu-28 (Lady Rosetta) gave the highest percentage of dry matter (21.50). Barcelona gave more large (40 to >55mm dia.) size tubers which made great contribution towards percentage of tuber number (32.31) and tuber weight (36.13). Seed tuber grade percentage was satisfactory performance among the genotypes and over the locations. All the tested varieties were mature between 80 to 95 days but Montecarlo was different and that was very early mature (72 days). YP-04-80 and Tomensa performed better than check regarding taste, appearance and texture of boiled potato. Finally, it can be concluded that Barcelona can be selected for early bulker; Montecarlo can be selected as early mature; and Barcelona and YP-04-80 can be selected as high yielder with good taste, texture and appearance of boiled potato Caruso and Tomensa need to be selected due to its high qualities of processing.

Table 5. Tuber yield at 90 DAP of selected genotypes as influenced by different environments of potato, 2014-15.

Variety/location	Bogra	Debigonj	Gazipur	Jamalpur	Jessore	Munshigonj	Mean
Bercelona	33.08	70.13	44.44	38.29	38.33	38.10	43.73a
Connect	30.93	46.71	35.02	44.44	36.02	29.40	37.09b
Caruso	23.65	43.80	32.78	39.49	26.71	28.57	32.50def
Cumbica	25.94	47.13	27.37	42.26	31.11	31.37	34.20cd
Endeavour	30.91	43.99	25.85	33.96	28.47	32.47	32.61def
Montecarlo	35.79	46.69	19.31	30.71	23.20	29.42	30.85f
Rumba	36.86	47.66	29.72	38.18	33.29	25.97	35.28bc
Svenja	19.98	43.92	18.99	32.92	23.01	29.83	28.11g
Tomensa	22.87	30.20	20.14	23.57	24.17	20.03	23.50h
YP-04-80	38.41	45.36	29.70	43.30	30.51	31.83	36.52b
Diamant	33.42	44.57	27.46	31.62	31.62	30.33	33.17de
Asterix	30.68	43.46	30.62	32.98	27.22	27.90	32.14ef
L.Rosetta	26.42	37.59	21.78	28.00	22.22	26.97	27.16g
LSD value						4.735	1.933

Regional yield trial with exotic potato varieties

Six exotic table potato varieties as Set-I namely Flamenco, Folva, Gorgina, Kufri Jyoti, Pamela and Rossagold along with check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and four exotic processing potato varieties as Set-II namely Atlantic, Crips 4 all, Destiny, Dolly along with check varieties BARI Alu-28 (Lady Rosetta) were evaluated at six different agro ecological environments/locations during 2014-15 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 except Rosagold at 65 DAP but in Set-II yielded higher than check variety except Destiny at 65 DAP and Crips 4 all at 95 DAP. Satisfactory dry matter percent was also in all tested exotic varieties in Set-I as tablepotato. 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 Flamenco, Folva, Gorgina, Kufri Jyoti, Pamela, Rossagoldand Atlantic, Crips 4 all, Destiny, Dolly are advance for release as table and processing commercial varieties respectively.

Participatory variety selection of exotic potato varieties

Six exotic potato varieties as Set-I namely Flamenco, Folva, Gorgina, Kufri Jyoti, Pamela and Rosagoldselected for table potato from last three consecutive years along with check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and four exotic potato varieties as Set-II namely Atlantic, Crips 4 all, Destiny, Dolly 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 average yield over six locations the highest yield (34.58 t/ha) was produced by the variety

Flamenco followed by Pamela (32.57 t/ha), Folva(31.23 t/ha), Gorgina(30.57 t/ha) and Destiny (30.10 t/ha) and the lowest yield 23.68 t/ha recorded in the variety BARI Alu-7 (Diamant). *Considering size, shape and colour, farmers of all locations showed their keen interest about the all exotic verities.*

Table 6. Performance of exotic potato varieties for tuber yield under PVS at 95 DAP in farmers field.

Variety/ Hybrid clone	Tuber yield (t/ha) at 95 DAP.						
	Joy	Jam	Mun	Jes	Bog	Debi	Mean
Set-I							
Flamenco	35.54	41.66	31.65	37.63	35.39	25.59	34.58
Folva	32.35	19.44	32.03	39.47	34.69	29.41	31.23
Gorgina	34.07	20.83	30.51	35.77	33.26	29.00	30.57
Kufri Jyoti	27.70	15.27	32.02	33.63	26.72	23.78	26.52
Pamela	35.78	19.44	31.30	44.27	35.39	29.23	32.57
Rosagold	26.96	20.13	20.52	33.47	39.10	28.40	28.10
BARI Alu-7 (Diamant)	30.95	15.27	20.99	29.60	26.43	22.05	24.22
BARI Alu-25 (Asterix)	33.33	20.83	23.44	30.40	27.87	26.56	27.07
Set-II							
Atlantic	29.88	18.05	26.75	40.53	36.83	27.87	29.99
Crips 4 all	21.67	22.22	21.61	27.43	30.83	21.57	24.22
Destiny	33.09	29.44	29.35	38.43	27.40	22.89	30.10
Dolly	28.92	15.97	23.94	36.63	31.80	26.32	27.26
BARI Alu-28 (L.Rosetta)	29.41	27.77	27.43	27.83	28.78	25.86	27.85

Development of heat tolerant potato variety

Set-I: observation trial with clonal hybrids for early heat tolerant selection

Though potato is cool loving crop, the long-term goal of breeding for heat tolerance is the development of germplasm with improved field level tolerance under variable temperature conditions. Using previously developed stress indices, this study presents results from high temperature screening of 12 genotypes in both the stress and non-stress condition in the field at Debigonj, Panchogor, Bangladesh during 2013-14 and 2014-15 cropping season. Paired trials were conducted in the field under high temperature (stress) and lower temperature (non-stress) conditions. The geometric mean (GM), Heat tolerance index (HTI) and Heat susceptibility index (HSI) were used to evaluate the genotypic performance under stress and non-stress conditions. The clone of potato took higher number of days to emergence, foliage coverage (%), and tuber weight/hill under non-stress condition than stress condition. On the other hand, plant height and number of tuber/hill were higher in stress condition than non-stress condition. Under heat stress condition, clone 11.95 performed the highest tuber yield, 40.65 t/ha and clone 11.80 performed the lowest tuber yield, 28.81 t/ha, whereas, under non-stress condition, the highest tuber yield was obtained from clone 11.95, on the other hand, the lowest tuber yield was obtained from check Granola and the figures were 53.73 t/ha and 38.05 t/ha respectively. Clone 11.95, 10.105 and 10.116 showed relatively higher HTI and GM and lower HIS and they overall ranked as first, second and third respectively. Heat intensity index (HII) was 0.24 in first year and 0.23 was in second year. The results indicate that it was possible to identify superior genotypes for heat tolerance based on their stress indices. Clone 11.95, 10.105 and 10.116 can be selected for multi-location evaluation.

Table 7. Analysis of the geometric mean (GM), heat susceptibility index (HSI) and heat tolerance index (HTI) on tuber yield/hectare for two trials under each high temperature stress and non stress conditions.

Treatment	1st year						2nd year						Average across trial				
	Stress	Non stress	GM	HSI	HTI	Rank	Stress	Non stress	GM	HSI	HTI	Rank	Stress	Non stress	HSI	HTI	Rank
10.35	37.87	44.04	0.93	0.59	0.77	6	33.52	49.44	0.82	1.39	0.74	8	35.70	46.74	0.99	0.75	7
10.59	34.07	44.58	0.87	1.00	0.70	9	40.74	51.71	0.89	0.91	0.94	2	37.41	48.15	0.95	0.82	5
10.90	38.00	46.26	0.91	0.75	0.81	3	40.00	50.43	0.89	0.89	0.90	5	39.00	48.35	0.82	0.85	4
10.105	38.70	49.18	0.89	0.90	0.88	2	38.15	54.08	0.84	0.77	0.92	4	38.43	51.63	0.84	0.90	2
10.116	36.02	47.92	0.87	1.05	0.79	4	36.04	57.40	0.89	0.60	0.92	3	36.03	52.66	0.83	0.86	3
11.50	32.87	47.41	0.83	1.30	0.72	8	39.26	45.69	0.93	0.61	0.80	6	36.07	46.55	0.95	0.76	6
11.77	30.92	48.41	0.80	1.53	0.69	10	40.37	44.38	0.95	0.39	0.80	7	35.65	46.40	0.96	0.74	8
11.80	34.09	42.44	0.90	0.83	0.67	11	23.52	44.9	0.72	2.05	0.47	12	28.81	43.67	1.44	0.57	12
11.93	33.80	49.54	0.83	1.34	0.77	5	31.95	45.33	0.84	1.27	0.65	10	32.88	47.44	1.31	0.71	9
11.95	37.22	59.35	0.99	0.57	1.02	1	44.07	48.11	0.96	0.36	0.94	1	40.65	53.73	0.47	0.98	1
11.105	39.63	41.87	0.97	0.83	0.76	7	36.80	39.45	0.97	0.29	0.65	9	38.22	40.66	0.86	0.71	10
Granola	33.80	38.45	0.94	0.91	0.60	12	32.22	37.65	0.93	0.62	0.54	11	33.01	38.05	0.57	0.57	11
Xs, Xp	35.58	46.62					36.39	47.38					35.99	47.00			
HII		0.24						0.23									

Heat intensity index (HII); Ranked by HTI

Set-II: observation trial with clonal hybrids for early heat tolerant selection

This study presented results from high temperature screening of 11 genotypes in both the stress and non-stress condition in the field at Debigonj, Panchogor, Bangladesh during 2014-15 cropping season. Paired trials were conducted in the field under high temperature (stress) and lower temperature (non-stress) conditions. The geometric mean (GM), Heat tolerance index (HTI) and Heat susceptibility index (HSI) were used to evaluate the genotypic performance under stress and non-stress conditions.Under the heat stress condition, the highest tuber yield obtained from clones 12.8 and it was 51.83 t/ha while the lowest tuber yield obtained from check Granola and it was 32.22 t/ha. Under non-stress condition, the highest tuber yield obtained from clone 12.7 and the figure was 60.90 t/ha, whereas the lowest tuber yield obtained from clone 12.20, the figure was 25.46 t/ha. From the results it can also be observed that tuber yield under non stress was higher than stress condition. Clone 12.8, 12.13 and 12.7 showed relatively higher HTI and GM, and lower HSI and moreover, they ranked as first, second and third respectively. Heat intensity index (HII) was 0.20. These clones need to be selected for father evaluation to get precise information.

Table 8. Analysis of the geometric mean (GM), heat susceptibility index (HSI) and heat tolerance index (HTI) on tuber yield (t/h) for two trials under heat stress and non stress conditions during 2014-15.

Treatment	tuber yield/hectare					
	Stress (Ys)	Non stress (Yp)	GM	HSI	HTI	Rank
12.13	45.28	56.42	0.90	1.84	22.20	2
12.17	33.06	33.92	0.99	0.24	9.74	10
12.20	23.50	25.46	0.96	0.72	5.20	11
12.22	35.28	51.03	0.83	2.87	15.64	5
12.26	32.50	35.87	0.95	0.87	10.13	9
12.27	34.17	51.88	0.81	3.18	15.40	6
12.28	40.00	50.83	0.89	1.98	17.67	4
12.40	34.44	41.57	0.91	1.60	12.44	7
12.7	38.33	60.90	0.79	3.45	20.28	3
12.8	51.83	53.51	0.98	0.29	24.10	1
Granola	32.22	37.65	0.93	1.34	10.54	8
Xs, Xp	36.42	45.37				
HII		0.20				

Selection of heat tolerant potato variety(s) for early planting

Heat tolerant yield trial was conducted at BSPC, Debigonj during rabi season 2013-2014 and 2014-15. Ten BARI released potato variety and one advanced breeder line of CIP were included. BARI Alu-41 performed the highest number of tuber/hill (15.40), tuber weight/hill (0.688 kg) and Courage performed the lowest number of tuber/hill (8.73), tuber weight/hill (0.468 kg). Under heat stress condition, BARI Alu-41 performed the highest tuber yield, 45.89 t/ha and Courage performed the lowest tuber yield, 32.21 t/ha. Provento, Sagitta and BARI Alu-36 gave higher yield than check Granola as well as heat tolerant CIP clone CIP-120 too. BARI Alu-41 is solely superior heat tolerant variety but Provento, Sagitta and BARI Alu-36 could be planted.

Table 9. Field performance of the varieties at BSPC, Debigonj, Panchgonj during 2013-2014 and 2014-15 crop season.

Genotypes	Tuber number /hill			Tuber weight /hill			Tuber yield (t/ha)		
	Year 1	Year 2	Mean	Year 1	Year 2	Mean	Year 1	Year 2	Mean
BARI Alu 12 (Dheera)	12.47	14.60	13.54	0.481	0.675	0.578	32.07	45.02	38.55
BARI Alu 22 (Provento)	8.80	12.33	10.57	0.537	0.727	0.632	35.83	48.44	42.14
BARI Alu 28 (L. Rosetta)	7.60	10.00	8.80	0.480	0.573	0.527	32.02	38.19	35.10
BARI Alu 29 (Courage)	6.73	10.73	8.73	0.432	0.504	0.468	28.83	33.59	31.21
BARI Alu 31 (Sagitta)	9.13	10.27	9.70	0.582	0.663	0.622	38.78	44.18	41.48
BARI Alu 36 (4.26R)	10.53	12.33	11.43	0.532	0.711	0.621	35.46	47.41	41.43
BARI Alu 41 (5.183)	13.80	17.00	15.40	0.639	0.738	0.688	42.59	49.18	45.89
BARI Alu 44 (Elgar)	10.20	13.27	11.73	0.490	0.649	0.569	32.65	43.26	37.96
BARI Alu 45 (Steffi)	12.60	14.13	13.37	0.456	0.622	0.539	30.39	41.44	35.92
BARI Alu 13 (Granola)	11.07	13.73	12.40	0.514	0.664	0.589	34.26	44.29	39.28
CIP-120	10.40	12.67	11.53	0.476	0.629	0.553	31.74	41.96	36.85

Germplasm evaluation and selection

Participatory advance selection trial of virus resistant cip potato clones

An advance participatory varietal selection trial was conducted with 3 CIP virus resistant potato clones with 2 check variety Diamant and Asterix at 6 locations during 2014-15 crop season for their suitability and yield potentiality. Except Munshiganj, more than 90% emergence was recorded at 30 days after planting at all locations with all tested clones. At all locations, taller plant with vigorous plant growth was recorded in all CIP clones. Other morphological characters like, canopy coverage and stem per hill were showed significant variation. Yield (ton/ha) were varied significantly at all locations and mean range was from 29.67-45.44 T/ha. The mean highest yield was recorded in CIP-10(45.44 t/ha) and it was lowest in check variety Diamant (29.67 t/ha). All other CIP clones produced more than 37.0 t/ha average tuber yield. Through participatory variety selection, based on tuber yield, shape, size, colour, taste and ambient storage behaviour 2 CIP clones namely, CIP 10 (CIP 397029.21) and CIP 13 (CIP 397073.7) were selected for RYT in next cropping season.

Participatory advance varietal selection trial of cip promising potato clones

An advance participatory varietal selection trial was conducted with 3 CIP promising potato clones with 2 check varieties Diamant and Asterix at 6 locations during 2014-15 crop season for their suitability and yield potentiality. Except Munshiganj, more than 90% mean emergence was found at 30 days after planting at all locations. At all locations vigorous plant growth was recorded in all CIP clones. Other morphological characters like, plant height, canopy coverage and stem per hill were varied significantly. Tube yield (ton/ha) were varied significantly at all locations among the clones/varieties and mean ranged from 18.56-54.54. The highest yield was recorded in CIP-126(54.54t/ha) and it was lowest in check variety Diamant (18.56 t/ha). All the CIP clones produced more than 37.0 t/ha average tuber yield. In the farmers field trials, the highest yield was obtained in CIP-126(43.45 t/ha followed by CIP-112 (41.84 t/ha). Regarding pest and diseases minimum/lowest infections were found in CIP clones. Through participatory variety selection, based on tuber yield, shape, size, color and taste 2 CIP clones namely, CIP-112 and CIP-126 were selected for RYT in next cropping season.

Participatory varietals selection of cip clones through mother & baby trial approach for processing qualities

Fifteen CIP advance clones with three improved potato varieties were included in the Participatory Mother and Baby trial at two locations namely; RARS, Jessore and Barisal during 2014-15 for their characterization on growth, yield and postharvest processing performance suitability. In the trial, at both 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 CIP120 ranked 1st followed by CIP-213, CIP-202, CIP-246 and CIP-224. At harvesting stage under mother& baby trials, CIP-213 performed best as selected first followed by CIP-224, CIP-246, CIP-225 and CIP-202. The mean highest yield from mother trial was found in CIP-224 followed by CIP-235, CIP-224, CIP-239 and CIP-213.From the baby trials, CIP-239 produced the average highest yield followed by CIP-235, CIP-224, CIP-230 and CIP-120.Again, considering the mean of mother and baby trials at both locations, CIP-225 (43.19 T/ha) was ranked ad 1st, CIP-235 ranked 2nd and CIP-239 ranked 3rd position. CIP-213 and CIP-224 were in the 4th and 5th position, respectively. Evaluation of organoleptic on appearance, texture and taste, considering both locations CIP-223, CIP-224, CIP-230, CIP-231, CIP-235 and CIP-246 were found promising. After 90 days of storage in ambient condition, CIP-214, CIP235, CIP-205 showed best performance regarding weight loss, In case of rotted tuber number, the mean lowest was found in Lady Rosetta. No sprouting was found CIP-217 and CIP-235 up to 90 days after harvesting. Eight to ten clones will be selected for next season trial.

Participatory variety selection through regional yield trial of cip potato clones for heat tolerance

Two CIP elite potato clones with 2 check varieties Diamant and Asterix were planted in the last week of December at 3 locations namely ARS, Pahartoli, Chittagong, RHRS, Patuakhali and RARS, Jessore during 2014-15 cropping season to evaluate their suitability for heat tolerance. The tuber was planted almost one month late of the season to expose the crop to higher temperature in the late season compare with the normal time of planting. More than 90% of emergences of all clones were recorded from all locations. The morphological characters like, plant vigor, plant height, canopy coverage and stem per plant were found significant variation among the clones at all locations. At Chittagong, all the clones became senescence 7 days earlier than other two locations due to high temperature. At 81days after planting except CIP-127 (CIP 392820.1) and CIP 139 (CIP 396311.1) and rest two check varieties showed the highest senescence. At 65 days, CIP-127 and CIP-139 produced more yield than check varieties Diamant and Asterix. At maturity stage, it was observed that mean yield of all 3 locations, CIP-139 produced the highest (24.02 t/ha) tuber yield, followed by CIP-127 (23.60 t/ha). The check varieties Diamant and Asterix produced mean tuber yield of 20.78 and 20.70 t/ha, respectively. The crops were also evaluated through participation of farmers, researchers and extension staffs at vegetative, harvesting stage and under ambient storage condition. Finally, these 2 CIP clones viz. CIP-127 (CIP 392820.1) and CIP 139 (CIP 396311.1) were found promising for their good yield, shape and size, color of skin, texture and organoleptic test. These two clones CIP-127 and CIP-139 were recommended for release as heat tolerant varieties.

Participatory variety selection through regional yield trial (ryt) of cip potato clones for tolerance to salinity

Two CIP potato clones namely, CIP-102 (301029.18) and CIP-139(396311.1) along with 2 check varieties Diamant and Asterix were evaluated at three saline areas like, Kattoli, Chittagong, Kuakata, Patuakhali & ARS, Satkhira during 2014-15 cropping season for their suitability of salt tolerance. It was observed that tuber yield and other yield contributing characters like; plant vigor, foliage coverage, and plant senescence at 67 to 88 days after planting were varied significantly among the tested clones/varieties. At planting, in the main trial, the highest salinity level was recorded at Kuakata, Patuakhali (4.25 dS/m) and the lowest was at Chittagong (3.11 dS/m). During harvesting time, the highest salinity level was recorded at Kuakata, Patuakhali (18.02 dS/m) and it was lowest at Satkhira (7.95dS/m). But in the farmer's field trial, comparatively lower salinity level was recorded at Chittagong and Patuakhali but at Satkhira higher salinity level was recorded. Mean highest yield was observed in CIP 102 (21.85) followed by CIP 139 (21.27 t/ha) and Diamant (13.32 t/ha) was the lowest yielder. Based on tuber yield and senescence percent at three locations, CIP-102 and CIP 139 showed best performance, while the check Diamant and Asterix were the poor performer in saline condition. The crops were also evaluated through participation of farmers, researchers and extension staffs at vegetative, harvesting and under ambient storage condition. Finally, these 2 CIP clones, 2 CIP clones viz. CIP-102 and CIP- 139 were found promising for their good yield, shape and size, colour of skin, texture, organoleptic test and storability on ambient temperature. So, both CIP clones CIP-102 and CIP-139 were recommended for release as salt tolerant variety(s).

Morphological charcterization and documentatioin

Morphological characterization of advanced potato clones and exotic varieties

Thirteen (4 clones of RYT and 9 clones of AYT) advanced clones and 24 exotic varieties (14 varieties of RYT and 10 varieties of AYT) were characterized at Tuber Crops Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh during winter in 2014-15 following the DUS (Distinctness, Uniformity and Stability) descriptor which is approved by the National Seed Board of Bangladesh and descriptor of IBPGRC, Rome Italy. There were observed the morphological characteristics in addition agro-morphic characters too. Large variation was found among the genotypes and distinct characters were recorded which could be help to find out the respective variety as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Maintenance breeding

Maintenance of released potato varities, germplasm, lines and tps parents

A total of 951 kg seeds of potato were preserved in Breeder Seed Production Center coldstore, Debiganj, Panchagarh collected from 203 potato variety/germplasm/hybrid clone during 2013-14.The preserved materials will be used in future for variety development programme.

Multiplication, purification and maintenance of indigenous potato varieties

Among the tested genotypes of indigenous potato cultivars, Lalpakri produced the highest yield (13.88t/ha) followed by Indurkani (11.33t/ha), Sindirkouta (9.22t/ha), Shilbilati (8.44 t/ha) and Challisha (7.88 t/ha).Cultivar Sadaguti yielded the lowest (5.70t/ha). 46.40 kg Seeds of tested cultivars are stored at BSPC, BARI, Debiganj, Panchagarh cold storage for next year trial and maintenance purposes.

Production Technology

Screening of cip potato clones for nacl salinity stress under control condition

A pot experiment was conducted at Tuber Crops Research Center, BARI, Joydebpur, Gazipur to assess the effect of salinity (NaCl)on growth and yield of potato under control condition. Seven levels of salinity (6, 8,10,12,16 and 20 dS/m) including control treatment were used to evaluate nine CIP clones namely, CIP-101(301024.14), CIP -102 (301029.18), CIP-111(380583.8), CIP-112 (380606.6), CIP-117 (386292.3), CIP-120 (389429.31), CIP-124 (392781.1),CIP-130 (393617.1), CIP-139 (396311.1) with two check varieties namely, BARI Potato 25 (Asterix) and BARI Potato 7 (Diamant). From the trial it was observed that all the growth and related parameters studied, showed declining tendency with the increase of salinity level. Minimum days were required for emergence at zero salinity level. With the increasing of salinity level, potato clones took more days to emerge. Out of 11 clones/varieties, only 4 CIP clones, CIP-102, CIP-112, CIP-124 and CIP 139 were able to germinate at 10 dS/m salinity level. At higher level of salinity (12-20 dS/m) potato clones/varieties failed to germinate. Three CIP clones namely, CIP-102, CIP-111 and CIP-139 accumulated higher amount of Proline when they were subjected to higher salinity level. At 10 dS/m of salinity level CIP-102 produced highest tuber yield followed by CIP-139. These 2 clones also performed better and have the potentiality to survive at saline condition.

Screening of potato varieties against salt tolerance at field

Five varieties namely BARI Alu 34 (Laura), BARI Alu 25 (Asterix), BARI Alu 28 (Lady Rosetta), and BARI Alu 8 (Diamant, BARI Alu 41 (5.183) were evaluated at Kuakata, Patuakhali and ARS, Satkhira during 2014-15 for their suitability against salt tolerance. The results revealed that all the tested varieties were showed moderate salinity tolerance by considering more than 20 t/ha yield.

Bulking behaviour of promising potato varieties and germplasm

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2014-2015 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 40 DAP and continued up to 90 DAP. Six promising potato varieties such as Bari Alu40 (4.45w), Bari Alu41 (5.183), Bari Alu42 (Agila), Bari Alu43 (Atlas), Bari Alu44 (Elger) and Bari Alu45 (Steffi) were included in the study. Tuber yield was increased up to 90 DAP for all the varieties/Germplasm. The highest tuber yield (55.86ton/ha) was recorded in BariAlu45 (Steffi) when harvested at 90 DAP. On the other hand the lowest tuber yield was found in BariAlu43 (Atlas) when harvested at 90 DAP. The percent dry matter was increased up to 90 DAP for all the varieties. The growth rate of tuber was higher at 60 – 70 DAP for all the varieties except Bari Alu41 (5.183). Incase of Bari Alu41 (5.183) tuber growth rate was higher at 70-80 DAP.

Efficacy of new herbicide krizin 70% WP (metribuzin 70% WP) against bathua weed (*Chenopodium album)* in potato fields

A field experiment was conducted at the research field of tuber crops research centre,BARI during rabi season of 2014-2015 to find out the optimum rate of herbicide and time of application against Bathua (Chenopodium album) in potato fields. Efficacy of herbicide Krizin 70 % wp in controlling weed was evaluated by spraying it at final land preparation and 7 days after planting. There were six treatment viz. T_1=control (no weeding),T_2=hand weeding at 40 DAP,T_3= Krizin 70% wp @ 1gm/lit spray at land preparation T_4= Krizin 70% wp @ 1.5 lit/g spray at land preparation T_5= Krizin 70% wp @ 1 g/lit spray at 7 days after planting, T_6= Krizin 70% wp @ 1.5 g/lit spray at 7 days after planting .Result showed that the highest tuber yield 26.98 t/ha was found in T_2(one hand weeding at 40 DAP) which is statistically similar with t6 (1.5 g/lit) and T_5(1 g/lit and lowest 16.63(t/ha) was obtained in T_1 (no weeding).However the maximum BCR was observed in T_6 and minimum in T_1

Study on the effect of mulching on the tuber yield and quality of potato

To find out a suitable mulch material for potato production is an important issue for the farmers. For meet up the demand six treatments viz. Rice straw, Water hyacinth, Saw dust, Black polythene and, White polythene along with Control (no mulch) were used to find the best materials that can help the farmers to improve their production practice. Now a day's mulching has become an important factor for potato production. All the mulches have significant influence on the growth, yield and yield contributing characters. The highest yield (34.21 t/ha) was found in the black polythene mulch that was statistically different from other mulch materials. The lowest yield (25.64) was found in control (no mulch) treatment .

Disease Management

General survey of major potato diseases of Bangladesh

A survey work was conducted to see the incidence of potato diseases in Bangladesh. Late blight disease incidence was relatively high in Bogra, Rangpur, Jamalpur, Debiganj (Panchagarh), Munshiganj and low in Rajshahi, Jessore, and Comilla. Common scab was high incidence and bacterial wilt, stem rot, stem canker and black scurf, black leg, PVY, mosaic were as less disease incidence of potato in Bangladesh.

Efficacy of new fungicides in controlling late blight of potato

A total of 64 fungicides were tested against late blight disease of potato at three locations in Bangladesh. 16 fungicides in TCRSC, Bogra and 17 fungicides in RARS, Burirhat, Rangpur and 31 fungicides in RARS Jamalpur were used to reduce the disease under field condition. Results revealed that both three locations 54 fungicides (Magazeb 80 WP, Mythen 80 WP, Magadomeal, Goldme, Amazeb 80 WP, Sprit 75 WP, Foster, Carb 75 WP, Vita plus 80WP, Ecoman 80 WP, Pazodi, Azomil, Dominion, Micra 72 WP, Mycozeb 80 WP, Panda 72 WP, Monjil 72 WP, Nister76 WP, Cycozeb 72 WP, Maxima 80 WP, Nister 72 WP, Autoback, Zeba 72 WP, Navara 28 Sc, Mona 28 Fc, Dithan M-45 and Secure,A- Plus 72 WP, Pathan gold 80 WP, Ebad 69, Acmezeb 80 WP, AB-maroxyl 72 WP, Infinito 72 WP, Growthan 80 WP, Sprit 72 WP, Manfil 80 WP, Altima 75 WP, Agrolex 72 WP,Eponil 500 SC, Agromet Plus, Nasa 80 WP, Ticozeb 80 WP, Vicozeb 80 WP, Mararch 75 WP, Foster M – 80 WP, Preneb 70 WP, Fulimain 60 WP, Azcor 32.5 SC, Monjil 72 WP, Royal M-45, Titazeb 80 WP, Etofil M-45) showed excellent performance to combat the disease where they showed 80% disease reduction over control and yield was also good.

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 2014 – 2015 at Regional Agricultural Research Station, Burirhat, Rangpur and Tuber Crops Research Sub-Center, Bogra 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 lower disease were observed in the two resistant varieties than the susceptible variety. In case of yield, significantly the highest yield was obtained from the resistant variety BARI ALU-46. Statistically similar yield was obtained from resistant BARI ALU-53 and susceptible Diamant in both locations. In the interaction of variety and spray schedule it is observed that in the unsprayed condition the disease was much less in the resistant varieties than the susceptible variety. The highest yield of 69.95 t/ha was obtained from BARI ALU-46 at Rangpur with 4 sprays.

Screening of potato germplasm against late blight under natural field condition

The experiment was conducted at TCRSC, Bogra and RARS, Burirhat, Rangpur under natural field condition during rabi season of 2014-15. In Bogra it was found that among the 21 varieties/germplasm, only two (BARI Alu-46 and Sarpomira) showed resistant reaction and one as moderately susceptible and rest 18 susceptible to *Phytophthora infestans*. In RARS, Burirhat, Rangpur out of 20 varieties/ germplasm only three (BARI Alu-46, BARI Alu-53, Sarpomira) showed resistant and rest 17 showed susceptible reaction to late blight under field condition.

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

Eleven BARI released varieties including two checks as Diamant and Cardinal were evaluated at Tuber Crops Research Sub-centre of Comilla during 2014-15 cropping year under the field condition at rabi season. Considering scab incidence and severity, Lady Rosetta performed better for showing sort of resistance to common scab of potato.

Development of IDM package against common scab disease of potato

An experiment was conducted at TCRC, BARI, Gazipur to find out the effect of different combination of seed and soil treatments in controlling common scab of potato var. Diamant and Cardinal. A total of nine (9) treatments including control were selected for different combinations of seed and soil treatments using the different chemicals as Boric acid, Staple bleaching powder, Dithane M-45 and Provax. The effect of treatments varied among them to reduce common scab of potato on the both varieties. The treatment T_7 means combinely seed treatment with Provax @ 0.3 % and Soil application with Boric acid @ 15 kg/ha before sowing found to be more effective to control common scab based on disease incidence and severity on the both varieties. However, the germination and yield were not affected by the treatments, additionally the yield and germination increased by the treatments compared to control.

Evaluation of potato varieties/germplasms for plrv and pvy resistance under the infection pressure (first progeny)

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

Evaluation of potato varieties/germplasms for plrv and pvy resistance under the infection pressure (second progeny)

Twelve exotic potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) at Joydebpur, 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 at Joydebpur. Data were taken on percent PLRV and PVY incidence, germination and yield. In growing up test during 2014-15, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameters, Berdi performed better in this year. The experiment will be repeated in the next season.

Evaluation of potato varieties/germplasms for plrv and pvy resistance under the infection pressure (third progeny)

Twelve exotic potato varieties were evaluated against PLRV and PVY to find out resistant source (s) at Joydebpur, Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2012-13 at Joydebpur. Data were recorded on percent germination, PLRV, PVY, Yield and plant vigour. In subsequent growing up test during 2014-15 as the third generation, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameter, only one variety namely Caruso found to be better for showing free to very lower infection PLRV and PVY.

Screening of advanced cip potato clones against virus diseases

A total of nine CIP clones were evaluated against PLRV and PVY to find out resistant source (s) for releasing the suitable tolerant varieties at Joydebpur, Gazipur. All CIP clones including the check variety Diamant and Asterix were exposed to the infection pressure of PLRV and PVY in this cropping season. Data on percent PLRV and PVY incidence, germination, yield and vigor were taken. As the crop grown from disease free foundation seeds, there was no virus observed in the trial. In the coming season sample tubers will be planted so record the virus infection specially, PLRV and PVY to compare the clones for tolerance to diseases In case of yield, CIP clones performed better than check variety Diamant and Asterix comparing yield and other parameters. CIP-126 (43.25 t/ha) produced the highest yield followed by CIP-13 (42.37 t/ha), CIP-2 (41.45 t/ha), CIP-139 (40.43 t/ha), CIP-112 (38.54 t/ha) and CIP-111 (35.69 t/ha), respectively and it was lowest in the check variety Asterix (27.36 t/ha).

Seasonal abundance and diversity of virus diseases, aphids and correlation with temperature and humidity in potato

The field experiment was conducted on the seasonal abundance of viral diseases and aphids in relation with temperature and relative humidity in potato at TCRC, BARI, Gazipur during December 2014 to February 2015 with four potato varieties viz. Diamant, Cardinal, Granola and Asterix. Potato virus incidence as PLRV, PVX, PVY and PVS was very low in the foundation seed of Diamant and Asterix and Cardinal and Granola were free from virus. The yield highly reduced when virus infect the plant at the early stage of potato. Aphid abundance varied among potato varieties and was highly affected by time interaction. The highest number of aphids observed at 75 to 85 DAS of potato and the high temperature during maturity stage which ranged from 17.88 to 22.36. The aphids fluctuated their populations regardless the humidity during the potato growing season.

Insect Pest Management

Development of integrated management packages against potato cutworm in farmers field

The experiment was conducted in farmers filed (vill- Cornopur, Modhopara and Purbopara) at Bogra. The experiment was set at November 19, 2014 and laid out in a randomized complete block design (RCBD) with three dispersed replications and the variety cardinal was used for the study. Potato crop under IPM package T_1 (Sex Pheromone+ Furadan 5G during land preparation +Furadan 5G before last irrigation) result significantly lower percentage of hill damage (1.74%), damage tuber number (2.03%) and damage tuber weight (0.81) than other two treatments T_2(Furadan 5G during land preparation + Furadan before last irrigation) and T_3(Farmer's practice). The infestation status of IPM (T_1) and non-IPM (T_2 and T_3) plots are reflects in the yield. Comparatively higher yield was obtained from IPM plots (27.59 t/h) than T_2 (22.34 t/h) and T_3 (20.77 t/h). The most favorable benefit cost ratio (11.98) was found in T_2 (Furadan 5G during land preparation + Furadan 5G before last irrigation). Therefore, considering benefit cost ratio, Pheromone + Furadan 5G during land preparation + Furadan 5G before last irrigation could also be suggest may control the pest throughout the cropping season effectively.

Development of integrated management package's for the control of potato tubermoth (ptm) in field condition

Five IPM treatments were evaluated against potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) at Joydebpur during 2014 -15. The lowest percent damage tuber number recorded in T_3 (1.44%) treatment followed by T_4 (1.93%) treatment and they were statistically similar. Percent of maximum damage tuber by number was obtained in T_6 (7.91%) which was statistically significant with rest of treatments. Regarding marketable yield, it ranged among the treatments from 19.82 – 28.26 t / h. Maximum yield was found in T_3 (28.26 t/h) which were statistically similar with T_4 (28.00t/h) treatment. The highest benefit cost ratio (4.63) was found in T_3 (Sex pheromone + Hilling up). Therefore, from the results of the present study it was found that the treatment T_3 (Sex pheromone + Hilling up) may control the pest throughout the crop season effectively, economically and environmentally safer.

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 30 % to 98 % relative humidity) at two locations namely Joydebpur and Munshigonj. After harvest potato tuber covered with net before set the experiment. The experiment was set at April 1, 2014 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 both by number (11.05%) and weight (10.23%). 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 (0.89) was also found in that treatment followed by T_3. The no. of PTM increased drastically up to 3^{rd} and 4^{th} week of May where the PTM population reached accordingly 111M /T and 114 M/ T. 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 stooge trials was quite successful up to 4 months.

Soil, Water and Nutriet Management

Fertilizer dose for newly released potato varieties

An experiment was conducted to study the effect of nutrient management and variety on potato yield and soil properties at Grey Terrace soil of Joydebpur, Non-calcareous Grey Floodplain soil of Debiganj and Tista Meander Floodplain soil of Bogra. 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) closely followed by the TCRC recommendation.

Foliar application of zinc on potato

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debiganj during the Rabi season of 2014-2015 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 six different concentration of zinc such as: T_1 (control no Zinc), T_2 (Foliar application, FA at 0.038% ZnSO4 solution), T_3 (FA at 0.076% ZnSO4 solution), T_4 (FA at 0.114% ZnSO4 solution), T_5 (FA at 0.152% ZnSO4 solution) and T_6 (FA at 0.19% ZnSO4 solution). The tuber yield of potato was significantly influenced by foliar application of different concentration of zinc. T_5 showed the highest tuber yield (36.75 t/ha). The highest dry matter of potato was found in this treatment. The highest marginal benefit cost ratio was also recorded in this treatment.

Foliar application of boron on potato

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debiganj during the Rabi season 2014-2015 to study the effect of foliar application of boron on the yield and quality of potato. The experiment was laid out in a randomized complete block design (RCBD). The treatments comprised foliar application with six different concentration of Boron such as: T_1 (control- no Boron), T_2 (FA at 0.04% boric acid solution), T_3 (FA at 0.08% boric acid solution), T_4 (FA at 0.12% boric acid solution), T_5 (FA at 0.16% boric acid solution) and T_6 (FA at 0.20% boric acid solution). The potato tuber and dry matter yield were significantly influenced by foliar application of boron. The highest potato tuber and dry matter yield were found in T4. The highest marginal benefit cost ratio was also in this treatment.

Tissue Culture and Seed Production

In vitro maintenance of potato and sweetpotato germplasm

In vitro maintenance of potato and sweetpotato germplasm was initiated through sprout culture from the potato minituber (G_1) collected from BSPC, Debigonj and the sweetpotato germplasm received from CIP. The plantlets of both potato and sweetpotato were multiplied in MS media under aseptic condition. Several subcultures were done through single node cutting for short term conservation. A total of 127 germplasm of potato and 49 germplasm of sweetpotato were maintained at TCRC, BARI through *in vitro* multiplication. Among them, 43 BARI recommended varieties, 6 exotic varieties and 99 CIP potato clones were maintained in the Tissue Culture laboratory, TCRC, BARI. A total of 2780 plantlets of BARI varieties, 149 plantlets of exotic varieties and 1229 plantlets of CIP lines and 339 plantlets of 49 lines sweetpotato CIP clones were maintained in the laboratory as mother stock.

Large scale multiplication of disease free plantlets of bari potato varieties and other germplasm

Large scale disease free plantlet production of potato was initiated at both TCRC, BARI and BSPC, Debigonj during 2014-15 with the objective to produce sufficient first generation high quality minituber production of potato. The total number of 61,067 plantlets were multiplied from 16 varieties of BARI and 73 CIP clones of potato by TCRC, Joydebpur and BSPC, Debigonj jointly. Out of 44958 plantlets of BARI potato varieties 21,924 and 23,034 plantlets were multiplied by TCRC, BARI and BSPC, Debigonj respectively. A total of 16,109 plantlets from 73 CIP clones were multiplied at tissue culture laboratory, TCRC, Joydebpur during 2014-15. About 17,250 plantlets were sent to BSPC, Debigonj of which plantlets of BARI potato variety and CIP clones were 8230 and 9020 respectively. The remaining plantlets were planted in the TCRC nethouse at Joydebpur for minituber production.

Large scale production of seed minituber G_1) of potato

Minituber production of potato was initiated from virus free *in vitro* plantlets of potato at the tissue culture laboratory, TCRC, BARI and BSPC, Debigonj during 2014-15. A total of 4643 kg (4.64 tons) minitubers were produced during 2014-15 crop season from both BARI varieties and CIP clones. About 2.64 tons minituber was produced from 15 potato varieties of BARI of which 2.5 tons were produced at BSPC, Debigonj and 184 kg minituber was produced at TCRC, BARI, Joydebpur. The highest amount was contributed by the variety Cardinal (826 kg) followed by Diamant (350 kg), BARI Alu 40 (308 kg), BARI Alu 37 (266.8 kg), BARI Alu 35 (239.7 kg) and BARI Alu 41 (139.3 kg). The minituber of LB resistant variety BARI Alu 46 and BARI Alu 53 was also produced and it was 35 kg and 12.3 kg respectively.

Mortality, growth and minituber yield of *in vitro* grown potato plantlets as affected by different hardening methods

The experiment was conducted at the field net house of TCRC, BARI and BSPC, Debigonj during winter season of 2014-2015 with an objective to find out the best hardening method suitable for certain location. The experimental design was Completely Randomized Design (CRD) with three replications. Micropropagated potato plantlets of 20-25 days old of the Cardinal (BARI Alu 8) variety were used in the investigation. The treatments were two methods of hardening along with direct planting as control: $T_{1=}$ Transfer of plantlets in the plastic flat tray (45×30 cm) filled with media; T_2 = Keeping *in vitro* grown plantlets in the culture vessel without removing cap and placed in the nethouse for one week and T_3= Direct transplanting on bed (control).Location and different methods of hardening interacted significantly on growth and minituber yield of potato plantlets. Mortality percent was highest in the treatment T_2 (47.9%) and T_3 (37.5%) at Debigonj and lowest in T_1 and T_3 treatment at Joydebpur. Minituber weight per plant(114.5 g) was also highest at Debigonj when plantlets were hardened in plastic tray (T_1) and lowest at Joydebpur when practiced the same hardening methods. The highest minituber yield (8.0 kgm^{-2}) was observed at Debigonj when the plantlets were hardened in flat plastic tray (T_1) which was statistically similar to T_2 (7.1 kgm^{-2}) at Joydebpur. It was observed that the flat plastic tray is suitable for hardening at Debigonj but hardening in growing vessel (*in vitro*) is suitable at Joydebpur.

Optimization of minituber size and planting distance for the breeder seed production of potato

Six grades of potato minituber (<5 mm, 5-10 mm, 10-15 mm, 15-20 mm, 20-25 mm and > 25 mm tuber diameter) and four planting distance (25 cm, 20 cm, 15 cm and 10 cm) with a potato variety Diamant were taken in an study during 2014-15 at the Tuber Crops Research Centre of Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. The objective was to observe the effect of minituber grades and planting distance on growth, seed yield, increase ratio and seed potential of potato. The largest minituber (>25 mm) planted at widest distance (25 cm) produced maximum number of tuber per plant (18.7). The highest number of tuber per m^2(306.7) was obtained with largest minitubers (>25 mm) planted at the closest plant spacing 10 cm, while it was lowest (64.0) in smallest size minituber (<5 mm) with the widest distance 25 cm. The maximum percentage (53%) of 'A grade' seed (28-55mm size) was obtained from the 5-10 mm sizeminituber planted at 15 cm distance.The highest seed potential (39.8) was found in >25 mm size minituber planted at 10 cm distance. The lowest (0.99) was in <5 mm size minituber when planted at 25 cm distance. A significant increase ratio was found ranged from 12 using >25 mm minituber with the 10 cm planting distance to 269 using 5-10 mm minituber with 25 cm planting distance.

Minituber production of potato in the green house

Performance of plantlets of BARI developed five potato varieties has been evaluated to investigate their minituber yield. There was a significant variation among the varieties on mortality rate after transplanting the potato plantlets. The highest mortality rate was found in the variety BARI Alu 36 (49.8%) and the lowest mortality rate was found in the variety BARI Alu 41. Highest yield was found in the variety BARI Alu 40 (7.54 kgm^{-2}) which was statistically similar to BARI Alu 41 (7.26 kgm^{-2}). The results indicated that minituber of all the newly developed potato varieties can be grown in the newly built green house at TCRC, BARI though the yield was lower than nethouse multiplication. But further investigation is necessary for successful production of minituber in that green house.

Seed production of potato

The seed production program was initiated at TCRC, BARI and BSPC, Debigonj during 2014-15 to supply breeder seed to BADC and other private sectors. Under PNH, 15 varieties were grown to produce nucleus seed (minituber) from *in vitro* plantlets. Twenty seven varieties were grown under temporary field net house to produce breeder seed and 18 varieties were grown for foundation seed in the open field.About691.60 tons of seed potato were produced where 2.65 tons minituber and 286.0 tons breeder seed and 371.38 tons foundation seed were produced. An amount of 59.40 tons of breeder seeds were supplied to BADC (55.0 tons) and other private organization (4.40 tons).

Table 10. Total Potato Seed Produced (Class wise) 2014-15.

Sl. No.	Class of seed	BSPC, Debigonj			TCRC, Joydebpur	**Total (ton)**
		Seed sold before storing (ton)	Seed stored (ton)	**Total (ton)**	Total (ton)	
Minituber						
1.	Minituber (G_1) of BARI variety	-	2.459	**2.46**	0.184	**2.65**
Breeder seed						
2.	CIP	-	33.0	**33.0**	0.036	**33.04**
3.	BARI variety	59.40	125.01	**184.41**	0.525	**185.0**
4.	BARI variety (second cycle)		68.60	**68.60**	-	**68.60**
Sub-total (Breeder seed)						**286.04**
Foundation seed		1.80	369.42	**371.22**	0.164	**371.38**
Others						
5.	Seedling tuber	-	0.5	**0.5**		**0.5**
6.	Experimental seed	-	30.50	**30.50**	-	**30.5**
7.	Non seed		-			
Total		61.20	629.49	**690.69**	0.909	**691.60**

Post Harvest Technology

Storage behaviour of potato varieties and hybrid clones under natural condition

Seven storage experiment was conducted during 2014-15. Among these two are RYT (exotic and clonal). Three are AYT (clonal, exotic and CIP germplasm) and 2 are SYT (clonal and exotic). In case of exotic RYT, volumia, Metro and Elmondeo performed better. In clonal RYT, 8.37, 8.102 and LB-6 showed better performance. Regarding AYT, in clonal hybrid, 9.91 showed good marketability. In exotic varieties Flair showed better performance. In case of CIP genotypes CIP-1 and CIP-8 performed better. Regarding secondary yield trial (SYT), in exotic (batch 1), all the genotypes studied showed good performance. In clonal hybrid, 10.3, 10.58, 10.245 and 10.275 showed batter performance.

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

Fourteen exotic variety and four clonal hybrids of RYT were studied for their processing quality. Among the exotic variety and clonal hybids studied Sarfomira, Crisps 4 all, Atlantic, Kufri Jyoti,Dolly, 9.35, 9.112, 9.125 performed better than the others for chips and French fries. Sevenja, Barcelona, Endeovaur,10.105, 10.35, 10.27, Tomensa, Rumba, 10.245 performed better from Ten Exotic variety and Nine clonal hybrid of AYT for chips and French fries. Nine exotic variety and ten clonal hybrids of AYT were studied. Among the variety and clones Verdi, Forza, 11.77, 11.8, Yukon Gen, 11.93performed better for chips and French fries.

Quality seed potato production through seed plot technique at farmers level

A total of 300 farmer’s field trials conducted at 20 districts of Bangladesh showed very effective in producing quality seed tubers through seed plot technique. Incidence of virus, bacteria, common scab and late blight were very low compared to farmers practice. Production of quality seed potato through seed plot technique at farmers level found higher than the traditional practice. All farmers showed very positive reaction to introduce potato seed production programme under seed plot technique in order to produce quality seed tuber in their field in the coming seasons.

Varietal Development of Sweet Potato

Hybridization of sweet potato using random mating cross

A crossing program was under taken during 2014-15 at Joydebpur to develop variety(s) with high yield, dry fleshed and moderate carotene content. Nine parents were included in this study. Only five parents produced F_1 seeds. The highest number of F_1 seeds was collected from BARI SP-12 (340), followed by BARI SP-2 (98) and the lowest number of F_1 seeds produced by BARI SP-8 (7). These F_1 seeds will be sown in nursery bed next year for vine as well as tuber production and evaluation.

Preliminary yield trial with F_1C_2 hybrid clone of sweet potato

A trial was initiated at Joydebpur during 2014-15 cropping season. The hybrid clones were planted in the field for evaluation. Out of twenty two (22) clone following the selection procedure ten (10) clones were selected as promising for next year evaluations.

Secondary yield trail of F_1C_4 hybrid clones of sweet potato

A breeding program was initiated at Joydebpur during 2014-15 cropping season. The hybrid clones were planted in the field for evaluation. Considering marketable yield, dry matter (%), carotene content, overall acceptability score and other factors nine hybrid clones namely, $H_{10.25}$/10, $H_{12.25}$/10, $H_{17.EJ}$/10, $H_{16.EJ}$/10, $H_{11.01}$/10, $H_{4.01}$/10, $H_{5.EJ}$/10, $H_{8.EJ}$/10 & $H_{21.EJ}$/10 were selected for next year evaluation.

Advanced yield trial with F_1C_5 hybrid clones of sweet potato

Seven promising clonal hybrid namely $H_{1.1}$/09,$H_{2.2}$/09, $H_{8.6}$/09, $H_{9.6}$/09, $H_{10.2}$/09, $H_{16.2}$/09 and $H_{24.5}$/09 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2014-15 cropping season at five different agro ecological environment/locations in AYT. 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 $H_{24.5}$/09 yielded highest (26.63 t/ha) followed by $H_{9.6}$/09 (25.62 t/ha), $H_{1.1}$/09 (24.51 t/ha) and $H_{16.2}$/09 (24.28 t/ha). These hybrid clones yielded higher than check varieties in case of genotype mean over locations. Considering yield and yield contributing characters these four hybrid clones namely $H_{1.1}$/09, $H_{9.6}$/09, $H_{16.2}$/09 and $H_{24.5}$/09 were selected for next year trial.

Regional yield trial with F_1C_6 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 2014-15 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 $H_{24.5}$/09 yielded highest (26.63 t/ha) followed by $H_{9.6}$/09 (25.62 t/ha), $H_{1.1}$/09 (24.51 t/ha) and $H_{16.2}$/09 (24.28 t/ha). These hybrid clones yielded higher than check varieties in case of genotype mean over locations. Considering yield and yield contributing characters these four hybrid clones namely $H_{1.1}$/09, $H_{9.6}$/09, $H_{16.2}$/09 and $H_{24.5}$/09 were selected for next year trial.

Regional yield trial with CIP clones of sweet potato

Three promising CIP clone namelyCIP-441132,CIP-194513.15, CIP-440267.2along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2014-15 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-441132 yielded highest (28.23 t/ha) followed by CIP-194513.15 (26.51 t/ha), CIP-440267.2 (26.49 t/ha) and lowest yield BARI SP-4 (24.88 t/ha). Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these three CIP clones namely CIP-441132, CIP-194513.15andCIP-440267.2were selected for confirming performance on next year trial.

Regional yield trial with F_1C_7 hybrid clones of sweet potato

Three promising clonal hybrid namely H_3/07,H_{21}/07 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2014-15 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_3/07 yielded highest (29.93 t/ha) followed by H_{21}/07 (26.44 t/ha) and the lowest yield BARI SP-4 (23.95 t/ha). These hybrid clones yielded higher than check varieties in case of genotype mean over locations. Considering the yield and yield contributing characters two hybrid clones namely H_3/07 and H_{21}/07 were recommended to release as commercial variety.

Participatory variety selection trial with F_1C_7 hybrid clones of sweetpotato

A participatory variety selection trial at farmer’s field of Bogra, Jamalpur and Jessoredistrictwas carried out with two hybrid clones namely H_3/07, H_{21}/07 and two check variety BARI SP-4 and 8 during the winter season of 2014-15. From the mean yield of three locations the highest yield (31.14 t/ha) was obtained by H_3/07 and the lowest (26.99 t/ha) in BARI SP-4.

Participatory variety selection trial with CIP clones of sweetpotato

A participatory variety selection trial at farmer’s field of Bogra, Jamalpur and Jessore district 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 2014-15. From the mean yield of three locations the highest yield (29.56 t/ha) was obtained by CIP 440267.2 followed by CIP 441132 (28.76 t/ha) and the lowest (26.09 t/ha) in BARI SP-8.

Preliminary observational trial with CIP clones of sweetpotato

Forty six newly introduced CIP sweetpotato clones were planted in the research field of TCRC, Gazipur for evaluation of their performance in relation to develop high yielding, early bulking, weevil resistance and high dry matter content orange fleshed sweetpotato varieties in Bangladesh.All the clones were morphologically characterized and evaluated as leafy vegetables. Plant height of the clones varied widely and ranges from 44cm to 149.5cm. Number of branches per plant at 120 DAP ranges from 4.25 (CIP440140) to 9.50 (CIP106282.1). Most of the clones had the highest foliage coverage (100%) while the lowest was recorded in CIP 106278.1 (40%). Most of the evaluated clones showed highly vigorous in nature on field performance and ranges from 4 to 5 scales. In organoleptic evaluation taste, most of the participants preferred much CIP106082.1 as leafy vegetables that scored 4.8 out of5 scale followed by CIP420001 (scored 4.5).Due to prolonged rain during harvesting period, the roots of the evaluated clones were damaged and not able to get yield data. The same trial will be set up in two locations (Gazipur&Jessore) on 2015-16 cropping season.

Screening of sweetpotato varieties for salt tolerance

Six BARI released sweetpotato variety and a local cultivar as checked were evaluated in Satkhira and Kuakata, Patuakhali during 2014-15 crop seasons for their suitability against salinity. All the studied variety of BARI performed better in a range of salinity level 1.02-9.20 dS/m at Satkhira and 1.37-12.37 dS/m at Kuakata, Patuakhali during crop growing period. Comprising both the location, BARI SP-12 produced the highest yield (33.57t/ha) followed by BARI SP-6 (31.29t/ha) & BARI SP-4 (29.46t/ha) while the lowest was recorded in BARI SP-13 (17.71t/ha) followed by BARI SP-7 (23.64t/ha). Considering the average yield performance of the variety in 2012-13, 2013-14 and 2014-15 cropping season, all the BARI release varieties performed better up to 12.37 dS/m soil salinity level and average yield was more than 22 t/ha in Satkhira and Patuakhali districts. However, among the studied varieties, BARI SP-4 produced the highest yield (31.36 t/ha) followed by BARI SP-6 (28.54 t/ha) and BARI SP-12 (27.18 t/ha).

Participatory selections of orange fleshed sweetpotato (OFSP) advance clones

Four CIP promising clones and two TCRC OFSP hybrid clones along with BARI SP-3, BARI SP-4, BARI SP-12 and BARI SP-13 were evaluated at research stations and farmers' fields of Barisal, Chittagong and Jessore regions of Bangladesh following Mother & Baby Trial Approach during 2014-15 cropping season. The crop was evaluated at vegetative and harvesting stage both in research station and farmers' field.Farmers, scientists and extension staffs are expecting in the upcoming sweetpotato varieties should have the characters like, disease & weevil resistance, dark green leaves with purple twigs, leaves are suitable for vegetable and nutritious, early maturing variety, year round cultivable, higher yield, good in taste, orange fleshed and high storability. Results at vegetative stage showed that, $H_{6.2/09}$ranked first followed by BARI SP-4 (2nd) and CIP 441132 (3rd) in Barisal. While in Chittagong, $H_{6.2/09}$ ranked first, BARI SP-4 scored second and CIP 194513.15 ranked third. While in Jessore, $H_{6.2/09}$ got highest preference followed by BARI SP-12 (2nd) and CIP 441132 (3rd) among all the studied clones/varieties.At harvesting stage, participants' preference goes to TCRC hybrid $H_{9.6/0,}$ BARI SP-4, BARI SP-12 and CIP 194515.15 in farmers and research station evaluation of Barisal, Chittagong and Jessore. Considering appearance of the roots after boil, flesh color, taste, presence of fiber and flesh texture during organoleptic evaluation of the harvested clones, $H_{9.6.09}$& CIP 194515.15 ranked highest followed by CIP-441132 and BARI SP-4, while farmers' choice was the poorest to BARI SP-12 and CIP-194513.15. Yield performance of the mother trial among 3 locations showed highest in $H_{9.6/09}$ (38.09 t/ha) followed by BARI SP-12 (31.20 t/ha), CIP-194513.15 (27.99 t/ha) and CIP 441132 (26.60 t/ha), on the other hand, the lowest was recorded in BARI SP-13 (12.71 t/ha) and BARI SP-3 (12.94 t/ha).For baby trials, $H_{9.6/09}$ gave the highest yield (30.09t/ha) followed by CIP 194515.15 (30.65 t/ha), CIP-440267.2 (27.81 t/ha) and CIP 441132 (27.45 t/ha) in all the locations.

Promotion activities on potato and sweetpotato under usaid horticulture project

With the funding of USAID, CIP/AVRDC has been implementing the Horticulture Project in Bangladesh since 2011-12. The following activities of potato and sweetpotato were implemented in 2014-15 cropping season to strengthen seed potato production system in farmers' level and to popularize orange fleshed sweetpotato (OFSP) with an objective to increase income and combating malnutrition in Bangladesh.

Effect of planting time and harvesting time on better yield of sweet potato

A field experiment was conducted at three locations (Gazipur, Debigonj, and Munshigonj) during October 2014 to April 2015 to find out the appropriate planting time and harvesting time in sweet potato. The treatment consisted of three planting time viz. 15 October, 15 November and15 December and the three harvesting time viz. 115 DAP (Day after planting), 130 DAP, and 145 DAP. The result revealed significant variation in respect most of the parameters.The treatment P_2H_2(planting time 15 November, Harvesting time130 DAP) appeared the best interacting treatments to achieve maximum yield at all locations like Gazipur ,Munshigonj and Devigonj (22.37 t/ha,40.43 t/ha and 37.47 t/ha) .

Screening of sweet potato varieties/germplasm against virus diseases

An experiment was conducted to screen the sweet potato lines against different virus diseases in 2014-15 cropping season at Tuber Crop Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Seventeen sweet potatoes germplasmswere evaluated including two check varieties (BARI-4 and BARI-8). In respect of lower virus infection and higher yield, H5/08 and H2/08 found to be the best lines among the tested germplasms when compared with the other two check varieties.

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

The experiment was conducted to study the effect of organic manure and chemical fertilizers on the yield, quality component and storability of sweet potato under integrated nutrient management at Grey

Terrace soil of Joydebpur and Tista Meander Floodplain soil of Bora. There were seven 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 (PM@ 3 t ha^{-1}+70% RDF), T6 (CD@ 6 t h^{-1}+ 70% RDF) and T7 (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 (36.6 t ha^{-}1) was obtained in T3 at Bogra, where poultry manure @ 3 t ha^{-1} along with reduced rate of recommended dose of chemical fertilizers were applied. The highest marginal benefit cost ratio (MBCR) was also recorded in the same combination. T3 and T4 showed better performance in respect of storage behavior at ambient temperature. Nutritional parameters will be incorporated after receiving the analytical values. The maximum nutrient availability was found in T3.

Production Technology

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Disease Management

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Breeder seed production of sweet potato 2014-15

Table 11. Breeder seed production of sweetpotato and aroids 2014-15.

Crop	Total production	Distribution
Sweetpotato	**Vine (no.)**	
BARI SP-1	10 000	CIP-USAID, DAE, NGOs, adaptive trials, AYT and RYT experiments and farmers
BARI SP-2	1,00,000	
BARI SP-3	4,000	
BARI SP-4	3, 00, 000	
BARI SP-5	50, 000	
BARI SP-6	1, 00, 000	
BARI SP-7	500	
BARI SP-8	2,00, 000	
BARI SP-9	500	
BARI SP-10	2,000	
BARI SP-11	50, 000	
BARI SP-12	-	
BARI SP-13	20, 000	
Total	**7, 38, 000**	

Adaptive trial of newly released sweet potato varieties at farmers field in different locations in Bangladesh

A field trial was carried out at different location of Bangladesh viz., Mymensingh, Patuakhali, Jamalpur and Jessore district during Rabi 2014-15 to evaluate the comparative performance of BARI released high yielding sweet potato varieties. In Mymensingh the trial consisted of four varieties viz. BARI SP-10, BARI SP-11, BARI SP-13 and a local check. The yield performance of almost all the varieties appeared to be promising in the tested locations. The highest tuber yield was recorded from BARI SP-11 (20.00 tha^{-1}) and the lowest yield was obtained from the local variety (11.46 tha^{-1}).Moreover, the highest gross return (3,00,000 $Tkha^{-1}$) and gross margin (2,37,640 $Tkha^{-1}$) was estimated from BARI SP-11 and local variety showed comparatively lower gross return (1,71,900 $Tkha^{-1}$) and gross margin (1,09,540 $Tkha^{-1}$).In Jamalpur, the highest tuber yield was obtained from BARI Sweet Potato-11 (43.53 t/ha) and BARI Sweet potato-13 gave lower yield (33.03 t/ha). Out of the tested sweet potato varieties, the highest gross return (Tk. 4,35,300/ha) was obtained from BARI Sweet Potato-11 which was also showed the highest gross margin (Tk.3,64,600/ha) as well as highest BCR (6.16).In Patuakhali BARI SP-11 gave higher yield for good number of tuber/plant (3.27) and highest tuber weight (530.60g). No. of tuber per plant was highest in local (3.80) and for higher tuber weight (448.0g) local produce second highest yield. Results revealed that the highest gross return (2,62,500 $Tkha^{-1}$) and gross margin (195170 $Tkha^{-1}$) was estimated from BARI SP-11 from Patuakhali. However, in Jessore, BARI SP-13 gave higher yield (27.63 t ha^{-1}) for good number of tuber/plant (7.8) and highest tuber yield per plant (0.620 kg) followed by BARI-11 (22.62 t/ha), local (19.28 t/ha) and BARI SP-10 (18.55). The highest gross return (276300 $Tkha^{-1}$) and gross margin (206300 $Tkha^{-1}$) was estimated from BARI SP-13 from Jessore.

Aroids and Minor Tuber Crops Breeding

Collection of aroids and other minor tuber crops gramplasms

A programme was taken to collect aroids and minor tuber crops germplasm by TCRC, BARI Gazipur during 2013-14. Thirty four materials of the six crops from 12 location were collected. 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, 21wereupland taro, 2 lowland taro, 2 giant taro and 3 cocoyam, 3 cassava and 9 Yams.

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

Three genotypes of Mukhikachu (C. esculenta),MK 122, MK 129, MK 131, MK 176 along with a BARI released variety Bilashias check were evaluated under regional yield trial. Among the genotypes,yield of MK 131 (28.08 t/ha) and MK 176 (27.81 t/ha) were found promising compared to check variety Bilashi (25.77 t/ha). The combined effect between location and genotypes was significant. When grown at Joydebpur location, the highest yield was obtained from check Bilashi (35.93 t/ha), followed by MK176 (33.70 t/ha) and MK-131 (33.43 t/ha) in the same location and MK122 in Jessore (32.60 t/ha).

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

Four genotypes of lowland taro (*C. esculentavaresculenta)*, PK 119, PK 109, PK 134, PK KHA1 along with two BARI released variety BARI panikachu 1 (latiraj) and BARI panikachu5 as check were evaluated under advanced yield trial. Results obtained from the experiment were presented in Table 6. The lowland taro or panikachu line PK 134 performed best among the experimented areas in respect of stolon production. The production of stolon ranged from 33.4 to 36.8 in different location. The rhizome yield of the line PK KHA 1 ranged from 45.3 to 46.7 tons per hectare. The line PK 134 may be suitable for stolon production and PK KHA may be suitable for rhizome production all over Bangladesh.

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 Joydebpur during 2013-14 at kharif season. The fungicide namely CM 75 wp showed the highest reduction of disease (58.55%) based on the percentage of disease incidence and foliar infection and gave the highest yield compared to other fungicides.

Production Technology

Nutrient management for mukhikachu (*Colocasia esculenta*)

An experiment was conducted at Tuber Crops Research Centre, BARI, Joydebpur during 2014 to update and optimize the fertilizer package and to maximize the yield of mukhikachu. There were four levels of nitrogen (0, 100, 130 and 160 kg ha^{-1}), four levels of phosphorous (0, 15, 30 and 45 kg ha^{-1}), four levels of potassium (0, 80, 110 and 140 kg ha^{-1}) and four levels of sulphur (0, 10, 20 and 30 kg ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The mukhikachu yield was significantly influenced by different combination of fertilizer. The highest mukhikachu yield (22.2 and 14.8 t ha^{-1} for corm and cormel, respectively) was found in $N_{130}P_{30}K_{110}S_{20}$ combination. The optimum doses of nitrogen, phosphorus, potassium and sulphur were 135.4, 29.7, 124.2, 20.9 kg ha^{-1}, respectively.

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 2014. Incidence of mite population reached high (41.51mites/ 2cm^2/leaf /plant) during 4th week of April when the weekly average temperature, relative humidity and rainfall were 33.1^{o}C,71.40 % and 12 mm respectively which is better for mite population growth. In case of population density,the most densely population found in older leaf (50.73%) followed by young leaf (36.23%) and newly emerged leaf (13.04%). Among the five treatments significantly the lowest percent of infested leaf per plant recorded in Vertimec (34.59%) 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 (89.93%) and it was significantly different from all other treatments. However, the reduction of mite population over control was maximum (70.11%) in T_4 (Vertimec 018 EC) treatment and closely followed by Soap powder+ alternate spray of Neem seed extract (60.16%) and they were significantly different from all other treatments. The yield of stolon was the highest in Vertimec 018 EC treated plots (18.15t/h). The most favorable benefit cost ratio (10.60) was found in T_2 (Soap powder + alternate spray of Neem seed extract). 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.

Breeder seed production of aroids 2014-15

Table 11. Breeder seed production of aroids 2014-15.

Crop	Total production	Distribution
Taro		
Lowland taro (Panikachu)	**Sucker (no.)**	
BARI Pani kachu-1 (Latiraj)	6, 00, 000	DAE, NGOs, adaptive trials, AYT and RYT
BARI Pani kachu-2	5, 000	’’
BARI Pani kachu-3	10, 000	’’
BARI Pani kachu-4	50, 000	
BARI Pani kachu-5	5, 0000	
Total	**6,70,000 suckers**	
Upland taro (Mukhi kachu)	**Cormel (kg)**	’’
BARI Mukhi kachu-1 (Bilashi)	4.5 tons	
BARI Mukhi kachu-2	500 kg	’’
Total	**5.0**	

3 PULSE CROPS

Blackgram

Hybridization and advancement of fillial generations in blackgram

Eleven progenies were confirmed from F_2 which will be evaluated in F_3 in the next season. Six families from F_6 generation were selected based on higher yield, disease resistance and seed size.

Growing F_2 generation of blackgram

Based on desirable traits 11 progenies were selected by comparing with check. Five to ten desired plants from each progeny were harvested and collected separately for the next year trial.

Growing of F_6 families of blackgram

Finally plant with desirable characters was identified and selected comparing with checks on the basis of yield, disease resistance and other desirable characters. Six families were selected which will be grown under observation trial in the next season.

Preliminary yield trial of blackgram

Eight Blackgram lines BBLX-07002-1, BBLX-07002-5, BBLX-07001-6, BBLX-07001-5, BBLX-07010-4, BBLX-06002-10, BBLX-02005-1 and 86337 were used in the experiment where BARI Mash 3 was used as a check variety. The genotypes BBLX-02005-1 gave the highest average yield (1315 kg/ha) among the genotypes followed by BBLX-07002-5 (1291 kg/ha). It also produced the highest seed yield in Jessore (1744 kg/ha) across the locations. Out of four locations BBLX-07002-5 genotypes produced a good yield (1291 kg/ha) on the other hand, the lowest average yield was obtained from the genotypes BBLX-07001-5 (970 kg/ha). The lines BBLX02005-1, BBLX-07002-5, 86337 and BBLX-06002-10 and BBLX-07002-1 gave good seed yield which were selected to evaluate in the next season in RYT over different locations.

Lentil

Hybridization and advancement of fillial generations in lentil

A total of 313 successful crossed seeds were collected from fifteen cross combinations derived from six parents. From F_1, F_2 F_3, F_4 and F_5 generation twenty, six, eleven, five and fourteen progenies were selected, respectively based on yield and other desirable traits with resistance against stemphylium blight.

Growing F_2 generation of lentil

Number of desirable segregating population was comparatively very low among the grown six F_2 progenies. So, for the retention of the large extent of variability, 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.

Growing F_3 generation of lentil

Finally plants with desirable characters were identified and selected comparing with checks on the basis of yield, disease resistance and other desirable characters. 5-22 plants were selected from different progeny and harvested separately which will be grown in F_4 genreation in the next season.

Growing F_4 generation of lentil

Finally plants with desirable characters were identified and selected comparing with checks on the basis of yield, disease resistance and other desirable attributes. 5-21 plants were selected from each progeny and harvested separately which will be grown in F_5 generation in the next season.

Growing F_5 generation of lentil

A total of fourteen lines were selected from five accessions on the basis of yield, earliness, 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.

Observation trial of lentil

Two entries BLX-09015 and BLX-09001 were selected to evaluate in PYT in the next rabi season.

Regional yield trial of lentil

Two entries BLX 06004-2 and BLX 06004-12 might be selected to evaluate in the next rabi season for PVS trial.

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

LR 9-25 (BARI Masur 8) produced comparable or higher yields under late planting condition. The early lines LRIL 22-133 and LRIL 22-70 can be suggested for late planting after adjusting their population with less spacing.

Regional adaptive trials on lentil in SAARC member countries

Three entries LT-07, LT-06 and LT-08 were found better in respect of yield and related attributes.

Effect of date of sowing on lentil growth and yield (APSIM)

A field experiment was conducted at PRC, Ishurdi and RARS, Jessore during *rabi* season of 2014-2015 to find out the effect of sowing date on the growth and yield in varying moisture, temperature and day length. There were three sowing dates i.e. early sowing (25 October/2014), Optimum sowing (10 November/2014) and late sowing (25 November/2014). It was laid out in a RCB design with three replications. The variety BARI Masur- 6 was used and seed rate was 35 kg/ha. In the experimental plots. Fertilizers @14-20-20-10 kg NPKS/ha were applied during final land preparation. Intercultural operations were done as and when required. Data on different growth parameters and soil related date were collected as required for the APSIM model. During harvest data on yield contributing characters were recorded from 10 randomly selected plants from each plot and grain yield was recorded from 2.0 m^2/plots and converted into kg/ha. The recorded data were statistically analysed and mean separation was done following LSD Test. There was a significant effect of dates of sowing on branches/plant, pods/plant and seed yield at PRC, Ishurdi but all the parameters were significant at RARS, Ishurdi. The 2nd date of sowing (10 November) produced the highest seed yield of 2990 kg/ha at PRC,Ishurdi and 1883 kg/ha at RARS, Jessore as well as high yield contributing characters which influenced to achieving higher yield. The lowest seed yield of 2220 kg/ha at PRC, Ishurdi and 1350 kg/ha at RARS, Jessore under late sowing condition due to less yield contributing characters for both the locations. The yield of Jessore is lower than Ishurdi due to lodging of crops by the high wind during the late pod development stage. Similar trend was observed in last year. After the optimum sowing, the decreasing trend of seed yield and yield contributing characters were found due to delay in sowing which reduced the growth period and also induced forced maturity. But in early sowing yield and yield contributing characters were less than optimum sowing due to lack of favourable temperature for optimum growth and development which enhaced less yield contributing chracters and induced forced maturity.

From the last two years study, it may be concluded that around 10 November is the optimum time for sowing lentil to achieving higher seed yield. But after modeling the range of sowing dates for achieving higher yields will be identified.

Effect of irrigation on yield yield components of lentil under different sowing method

The field experiment was conducted at PRSS, BARI, Gazipur, during r*abi* season of 2014-2015 to find out the effect of irrigation on growth and yield of lentil under different sowing methods. There were six levels of irrigation schedule like control (I_0), pre sowing (I_1), post sowing (I_2), irrigation at 30 Days After Emergence (DAE) (I_3), irrigation at pre sowing + 40 DAE (I_4), irrigation at post sowing + 40 DAE (I_5) and two sowing methods, broadcast (B) and line sowing 25 cm apart (L). It was laid out in a split-plot design with three replications. The irrigation levels were in the main-plot and sowing methods were in sub-plot. The sowing date was 12 November, 2014. Seeds of BARI Masur-6 were used @35 kg/ha. In the experimental plots fertilizers @14-20-20-10 NPKS kg/ha were applied during final land preparation. Intercultural operations were done as when required. Soil was collected before sowing and before every irrigation and weighted and then oven dried and weighted. The soil moisture was calculated through gravimetric method. At first 20 days after emergence (DAE) and then at 15 days interval 5 plants for each plot was collected and oven dried and weighted to find out the total dry matter. Plant population/m^2 at germination, at harvest and yield contributing characters were recorded from 10 randomly selected plants from each plot and grain yield was recorded from 6.0 m^2/ plot during harvest. The recorded data were statistically analysed. Total dry matter increased day by day and total dry matter was the highest in post sowing+irrigation at 40 DAE which was very similar to pre sowing+irrigation at 40 DAE and the lowest was in controll irrespective of sowing method. The highest seed yield was obtained from irrigation at pre sowing + 40 DAE which was similar to irrigation at post sowing + 40 DAE. There was a significant difference between line sowing and broadcast on all the characters except plant population at harvest and 1000 seeds weight where line sowing 25 cm apart produced the highest seed yield but variation was not more. Interaction between irrigation and sowing method had no significant variation on grain yield and yield contributing characters. But numerically the highest seed yield was obtained in I_4 (irrigation at pre sowing + 40 DAE) under line sowing which was very similar to I_5 (irrigation at post sowing + 40 DAE) under line sowing. Similar trend of results were foud in 2013-2014.

From the last two years study, it may be concluded that, two irrigations i.e. at pre sowing/ post sowings + 40 DAE is effective for achieving higher yield of lentil. Line sowing vs. broadcasting had less difference. However line sowing is advisable because of ease of intercultural operation after irrigation.

Up- scaling of relay cropping of lentil in the farmers field

A demonstration program on relay lentil was conducted in four districts namely-Pabna, Faridpur, Kushtia and Natore by OFRD scientists of BARI and Department of Agricultural Extension (DAE) personnel during rabi season of 2014-15. Each demonstration was about two hectare plot comprising of several farmers for each district. Seeds of BARI Masur 6/ BARI Masur 7 @ 50-55 kg/ha was sown as relay crop in the standing Aman rice fields under saturated moisture condition during 22 October - 22 November, 2014. Seeds were soaked overnight before sowing. Fertilizers @ 20-20-10 Kg/ha of PKS were applied as basal during sowing and N @14 Kg/ha was top dressed at 20-25 days after sowing. Rice was harvested retaining 25 cm straw height from the ground level. Weeding was done once and Rovral (50WP) was applied @ 0.2% twice starting from flowering stage to protect the crop against Stemphylium blight. Higher seed yield was 1958 kg ha^{-1} in Atghoria, Pabna followed by Chatmohar,Pabna (1838 kg/ha) and Sadar,Natore (1850 kg/ha). The lowest seed yield of 1357 kg/ ha was recorded from Sadar, Kushtia plant due to less population. BCR for relay cropping is quite high 3.82-5 due to high seed yield and less production cost. The farmers in this country usually cultivate lentil with land preparation by ploughing. Farmer's yield of conventional practice varied from 980-1480 kg ha-1 having an average yield of 1280 kg/ha.The low yield was due to late planting, cultivation of old varieties, not use of fertilizers and plant protection measures.

It is need, a Plot Project to increase area of relay cropping of lentil in the medium high to medium low lands of Bangladesh.

Response of Lentil to Micronutrients Application

A study was conducted at the research field of Regional Pulses Research Station, BARI, Madaripur, Pulses Research Sub-Station, Gazipur and RARS, BARI, Jessore during 2014-15 to estimate the effective doses of micronutrients (Zn, B and Mo) for lentil yield maximization. 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 yield components and seed yield of lentil was influenced significantly due to different micronutrients management. The maximum number pods per plant were recorded from the treatment T_5 at Madaripur and Gazipur which was significantly different with the others treatments, but statistically identical to T_8 at Madaripur while it was higshest in T_8 treatment at Jessore. Other yield contributing parameter, the highest 1000 seed & weight was also recorded in the treatment T_8 followed by T_5 and the lowest 1000 seed & weight was recorded in control. The average seed yield of three locations ranged from 959-1391 kg ha^{-1}. The highest seed yield was found in the treatment T_5 which was significantly higher than other treatments, except the treatment T_8 which was statistically identical at per T_5 at Madaripur and Gazipur but at Jessore, the highest yield was obtained from T_8 treatment. The lowest yield was recorded from T_1 treatment. The stover yield of lentil showed smilar trend as seed yield. The average BCR was the highest (4.21) in the T_5 treatment. Noted here, the yields of lentil were observed lower than the potential yield due to foot rot disease infestation at Madaripur. From the aforesaid results, it may be considered that the micronutrient management practice of $Zn_{2.0}B_{1.5}$ and $Zn_{2.0}B_{1.5}Mo_{1.0}$ with a blanket dose of N_{15} P_{20} K_{30} S_{10} kg ha^{-1} economically viable and suitable for lentil yield maximization in calcareous and terrace soils of Bangladesh.

Influence of Different Levels of Potassium on Nodulation Quality and Yield of Lentil

An experiment was conducted at Pulses Research Sub-Station, BARI, Gazipur during Rabi 2014-15 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}. Yield and yield contributing characters of lentil were influenced significantly due to different level of potassium. The plant height of lentil ranged from 29.1-34.2 cm and the numbers of branches per plant varied from 2.29-3.82. The tallest plant and highest number of branches per plant were found in the treatment T_5 which were significantly higher over the other treatments although some variation was observed in plant height-tallest plant was statitically identical to the treatment T_4. The lowest values were obtained from the treatment T_1. The number of pods per plant ranged from 22.5-61.7. The maximum number pods per plant were recorded from the treatment T_5 which was significantly higher over the others treatments and the lowest number pods per plant were observed in T_1 treatment. The highest number of seeds per pod (1.88) was observed in T_5 which was showed significantly different over the other treatment and the lowest value (1.43) in T_1 treatment. The thousand seed weight ranged from 17.4-20.9 g. The highest 1000 seeds weight (20.9 g) was also recorded in the treatment T_5 followed by T_4 treatment and the lowest 1000 seeds weight was recorded in control treatment. The highest seed yield (1442 kg ha^{-1}) was recorded from T_5 which was significantly higher over the other treatments, but statistically identical at per T_4. The lowest seed yield (961 kg ha^{-1}) was recorded from control treatment. Regarding stover yield of lentil, it was showed similar trend of seed yield. In case of nodulation, the maximum numbers of nodules per plant (21.2) were recorded from the treatment T_5 which was significantly higher over the other treatment. Regarding the cost and return analysis, the highest benefit cost ratio 3.69 was obtained from the treatment T_5. The lowest benefit cost ratio 2.60 was recorded from the T_1 treatment. Significant influence was observed in yield and yield component, nodulation due to application of potassium 60 kg ha^{-1} and BCR was also found maximum.

Efficacy of fungicides in controlling stemphylium blight of lentil

Several fungicides viz. Rovral 50 WP, Secure 600 WG, Bavistin DF, Folicure EW 250, Tilt 250 EC,Cordon 50WP and Anoral 50WP were tested for their efficacy against stemphylium blight of lentil. The lowest incidence and highest yield (1416 kg/ha) was observed in Rovral 50 WP (2g/l) sprayed plots and the highest incidence and lowest yield (949 kg/ha) was recorded in untreated control plots.

Screening of lentil lines against stemphylium blight under inoculated condition (ACIAR)

At PRC Ishwardi stemphylium blight disease severity was significantly lower in line LR 9-25, BLX 06004-2 and BLX 04004-3. Stemphylium blight disease severity was lower in BD-4053, BD-3807, LRIL-21-5888, LR-9-25, BLX-06004-2 and BLX-04004-3 at PRSS, BARI, Gazipur.In Madaripur BD-3810, BD-3853, BD-6008 and BD-6018 showed lower disease severity compare to check. These lines would have the way in breeding for high yielding Stemphylium blight resistant varieties.

Development of stemphylium blight of lentil under inoculated condition at different crop ages

Stemphylium blight is a major constraint for lentil production in Bangladesh. The disease is widespread and can destroy total population within a short period. The research on initiation and development of this disease demonstrated that it may occur at any stages of plant growth upon having congenial environmental condition.

Determination of spray time and number of rovral spray in controlling stemphylium blight of lentil (ACIAR)

Stemphylium blight disease of lentil is increasing tremendously in the recent years and continued to be a serious threat to the successful cultivation of lentil. Because of the increasing severity, the disease has already gain much more importance and reported to incur 80-92% crop loss. The coordination of time and number of spray study revealed that initial spray time of rovral should be at January20thand three spray at 7 days interval@ 0.2% is effectively controlling stemphylium blight of lentil.

Study on the survival of stemphylium in lentil crop debris in the field

The spore of *Stemphylium* was observed to survive up to 6 months in the soil surface, 10 cm and 15 cm depth of soil but it was viable only up to 5 months. No pseudothesia / ascospore production was observed within this period.

Efficacy of fungicides in controlling botrytis gray mold (BGM) of chickpea

Five different fungicides viz- Karjet M8 (Simoxanil + Mancozeb), Sanoxanil 72WP (Simoxanil + Mancozeb), Euthen 80WP (Mancozeb), Indofil M48 (Mancozeb) andTijeb Gold 75WP (Mancozeb+Carbendazim) were evaluated under natural condition. Results revealed that Karjet M8 and Sanoxanil 72WP treated plots showed reduced disease severity against BGM.

Pea

Hybridization of pea

A total of 207 successful crossed seeds were collected from thirteen cross combinations. Maximum numbers of successful cross seeds were found in BFP 11016 X Jhikorgacha Local. F_1 seeds have been stored for next year confirmation.

Regional yield trial of pea

Among the early genotypes, Early-94 and Pea 88 and among the long duration lines, BD 4228, BD 4223 and BD 4209 can be selected for testing in the appropriate cropping patterns in the farmer's field for final evaluation before releasing as varieties.

Evaluation of local pea genotypes

Significant differences among the genotypes were observed in case of days to flowering; days to maturity, pods/plant, 100 seed weight and yield in kg/ha. The entry Faridpur local flowered late and the check BARI Garden pea-3 flowered earlier among the genotypes. Again, BARI Garden pea-3 matured earlier and the entry BD-4142 matured late. Highest pods/plant was obtained from Bagha local. Among the entries highest yield was obtained from Natore local-1 followed by Jhikorgacha local and Natore local-2.

Development of management package for pea (var. BARI Motorshuti-3) for T.aman rice-pea-boro rice cropping pattern

A field experiment was conducted for the 2nd year at RARS, Jessore to find out the optimum seed rate, sowing method, irrigation and top dressing of urea for optimizing growth and yield of BARI Motorshuti-3 during rabi season of 2013-2014 and 2014-2015. The experiment was laid out in a split-split-plot design with 3 replications. Irrigation 0 and 1 at 20 days after emergence (DAE) (0,1) were placed in the main-plot, Urea top dress 0 and @ 45 kg/ha at 20 DAE (0,1) were placed in the sub-plot and line spacing (4) 20, 25 & 30 cm and broadcast @ 200 kg/ha as per farmer's practice were placed in the sub-sub - plot. A blanket dose of fertilizers @14-20-20-10 kg/ha of NPKS, respectively was applied in the experimental plots during final land preparation. The sowing date was 15 November, 2014 and seeds were sown as per treatment. Irrigation and urea top dress were done as per treatment. Intercultural operations were done as required. Data on yield contributing character were recorded from 10 randomly selected plants and pod and fodder yield from whole plot.Two times green pod were collected at 63 and 73 DAE, and after pod harvest brown plants were harvested and weighed. The data were statistically analysed using MSTAT-C software and mean values were judged by Duncan's Multiple Range Test. Combined effect of irrigation, urea top dress and spacing on green pod yield and fodder yield of BARI Motorsuti-3 were significant. The highest green pod (5833 kg/ha) was found in no irrigation, no urea application under 20 cm spacing and fodder yield (3594 kg/ha) was found in one irrigation, urea application at 20 DAE under 20 cm spacing. Whereas, the lowest green pod yield (3256 kg/ha) was found in one irrigation at 20 DAE, no urea top dressed under broadcast with seed @ 200 kg/ha but the lowest fodder yield (1651 kg/ha) was obtained by no irrigation, no urea top dressed under broadcast with seed @ 200 kg/ha. However, there was no remarkable variation on plant height, pods per plant and seeds/pod except plant population/m^2.

From the last two years study under RARS, Jessore soil it was found that if optimum soil moisture is ensured for germination there is no need of irrigation. Under this situation only closer plant spacing (20 cm) with seed rate 225 kg/ha is the key factor for achieving higher yield of green pod and fodder but other treatments effect (irrigation and urea top dress) is not remarkable.

On-farm validation of green pea as vegetable in the T.aman rice- pea (sole) - boro rice cropping pattern under upland condition

The present study was conducted at Jessore region (Jhikargacha & Monirampur, Jessore and Kaligonj, Jhinaidah and Bheramara, Kushtia) in the farmers field for the validation of growing pea (BARI Motorshuti-3) as vegetable crop in the T.aman- Pea -Boro rice cropping pattern under upland condition during 2014-2015. Unit Plot size was 1 bigha (0.13 ha) for per location. The fertilizer dose of BRRI dhan 39 was 85, 45, 26, 14 and 2.7 kg/ha of NPKS and Zn, respectively. For field pea (BARI Motorsuti-3) was sown after harvesting of T.aman rice (BRRI dhan 39) with proper land preparation. Fertilizers @ 14-20-20-10 kg/ha of NPKS, respectively were applied during final land preparation. Seed rate of 225 kg/ha was used. The seeds were soaked for 8 hours before sowing. Seeds were sown in line with 20 cm spacing. Normal cultural practices were followed. Green pods were harvested at 2 installments and finally green plants were harvested as fodder. Data on yield attributes were collected. BARI Moturshuti-3 was completely harvested by last week of January'15 except Kushtia where it was harvested on 12 January and following it Boro rice was planted by 1st week of February'15 and in Kushtia it was planted on 18 January'15. It was found that BARI Motorshuti-3 in the pattern has produced an extra crop without disturbing the existing T. Aman –boro pattern. Rice equivalent yield of pea pod was calculated using value of pea pod @ Tk 35/Kg and corresponding value of rice @ Tk 15/kg. Thus the average total productivity of the improved patterns of other 3 locations was 20.54 t/ha of rice and that of existing pattern was 11.40 t/ha which means that inclusion of pea in the pattern increased the total productivity by 80% over the existing pattern. The BCR of the improved pattern was also higher (1.77) than the existing pattern (1.38).

From the above study, the results revealed that BARI Motorshuti- 3 is easily fitted in T.aman-Fallow-Boro rice pattern. It produces rice equivalent yield almost equal to boro rice with much less cultivation cost and irrigation cost. Inclusion of one legume crop in rice-rice system which will improve productivity as well as improve soil health. Therefore the pattern should be promoted where possible. However, BARI Motoshuti-3 should be planted within 2nd week of November with higher seed rate (225 kg/ha) and closer spacing (20 cm).

Validation of relay cropping of pea with T. aman rice

An on farm validation programme of relay cropping of pea with T.aman rice under T.aman-pea-T.aus/jute cropping pattern was conducted at MLT site of Sadar Upazilla of Faridpur, MLT site of Atghoria, Pabna and MLT site of Jamalpur during 2014-15 under farmers' field condition. This validation programme was conducted on about 1.0 ha of land comprising several farmers. Seeds of cultivar, Natore local-2 @ 90 Kg/ha was broadcasted as relay 10-15 days before harvesting of T. aman rice within 12.11.2014 to 22.11.2014. Fertilizers were applied @ 14-20-20-10 kg/ha of NPKS, respectively as basal during seed sowing. Rice was harvested retaining 30-35 cm rice straw height from the ground level. One weeding was done at 30 DAE. . It was observed from the results that, the highest grain yield (2157 kg/ha) was harvested at Pabna, 1820 kg/ha at Jamalpur but the lowest at Faridpur (820 Kg/ha) due to seedlings death by sudden rain resulting less population and finally less yield. From the cost benefit analysis it appeared that the highest BCR (5.09) was obtained at Pabna and the lowest at Faridpur (2.17). These are quite high benefit indeed. Farmers wished to cultivate Natore local-2 cultivar in relay condition as an extra crop.

It should be continued in a large scale for increasing area and production of pea through the utilization of fallow land.

Effect of zinc and boron on yield and yield contributing characters of fieldpea

An experiment was conducted at on-station Madaripur, Gazipur and Jessore during Rabi season of 2014-15. 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}= $Zn_{3.0}B_{1.5;}$ and T_{16}= $Zn_{3.0}B_{2.0.}$ The interaction effect between Zn and B on the yields of fieldpea was observed statistically significant for all the locatons. The highest seed yield was obtained from $Zn_{3.0}B_{2.0}$ treatment followed by $Zn_{2.0}B_{2.0}$ and $Zn_{3.0}B_{1.5}$ treatments at Madaripur but at Gazipur and Jessore the highest seed yields were observed from $Zn_{3.0}B_{1.5}$ treatment followed by $Zn_{3.0}B_{2.0}$ treatment and the lowest yield was recorded from Zn_0B_0 in all the location. The average yield of three locations of fieldpea varied from 938-1554 kg ha^{-1} and the average highest percent yield increased in $Zn_{3.0}B_{2.0}$ treatment (66.1%) followed by $Zn_{3.0}B_{1.5}$ treatment (64.6%) over control. Other yield contributing characters such as plant height, pod length, branches per plant, pods per plant, seeds per pod and 1000 seeds weight were significantly influenced due to the combined application of Zn and B but some variations were existed at Gazipur where plant height, pod length, number of branches per plant, pods per plant and number of seeds per pod were non significant. The combined application of Zn and B showed significantly influences on yields and yield components of fieldpea than their single application.

Control of powdery mildew of pea

Nine treatments viz. Tilt 250 EC (0.5ml/l), Thiovit 80 WG (2g/l), Bavistin DF (1g/l) , Knowin 50 WP (2g/l), Kumulas DF (2g/l), Milk (1:10), Neem oil (5ml/l), Baking soda and control were tested for their efficacy against powdery mildew of garden pea. The lowest incidence and highest yield (1893 kg/ha) were observed in Thiovit 80 WG (2g/l), Kumulas DF (2g/l) and Baking soda (1 table spoon of baking soda + ½ tea spoon of liquid soap + 1 gallon of water) sprayed plot and the highest incidence and lowest yield (974 kg/ha) was recorded in untreated control plots.

Fungicidal management against rust disease of pea

Seven fungicides viz.Tilt 250 EC (0.5mi/l), Folicure (1ml/l), Contaf 5EC (1ml/l), Dithane M 45 (2g/l), Bavistin (1g/l), Secure (1g/l), Companion (2g/l) and control were tested for their performance against the rust disease of garden pea. Severity of rust disease scale ranged from 1.00-3.67. The lowest incidence (1.00) and highest yield (1637 kg/ha) were recorded in Tilt 250 EC (0.5ml/l) of water sprayed plots and the highest incidence (3.67) and lowest yield (1058 kg/ha) were obtained from untreated control plots.

Chickpea

Hybridization and advancement of fillial generations in chickpea

Hybridization and advancement of F_3 and F_5 generations were conducted during rabi 2014-15 at PRC, Ishwardi, Pabna. Six parents were used and a total of 254 successful crossed seeds were collected from sixteen cross combinations. From F_3 and F_5 generation six and fifteen progenies were selected, respectively considering higher yield and other desirable traits with resistance against BGM.

Growing F_3 generation of chickpea

Six F_3s were identified and selected comparing with check and 6-18 plants with desirable traits from different selected entries were collected. Their seeds were harvested separately and preserved according to population and plant for the next year experimentation.

Growing of F_5 families of chickpea

A total of fifteen lines were selected from four accessions on the basis of yield, disease resistance and other desirable characters e.g. pods per plant, seeds per pod, seed weight. Each of the selected lines will be treated as family and will be grown at observation trial in the next year.

Observation trial of chickpea

Highest pods per plant were found in BCX 09010-9 followed by BCX 09015-7 and BCX 09010-6. Bold size seeds were obtained from BCX 09015-7. The highest yield was obtained from BCX 09010-2 followed by BARI Chickpea-9, BCX 09015-7 and BCX 09010-6. Finally, four entries BCX 09010-2, BCX 09015-7, BCX 09010-6 and BCX 09010-9 on the basis of higher yield, higher pods per plant and bold seed size were selected for PYT in the next rabi season.

Preliminary yield trial of chickpea

The genotype BCX 08009-3 took lowest days to flowering as well as mature F_3. The highest mean pods per plant recorded from genotype BCX 08008-1 and lowest mean from genotype BCX 08009-3. Bold seeded entry was recorded as BCX 08009-9 where BARI Chola-5 possessed the smaller sized seeds. All genotypes showed moderate resistance to BGM. Maximum yield was obtained from BCX 08009-9 followed by BCX 08008-1. Finally BCX 08009-9, BCX 08001-3 and BCX 08008-1were selected to evaluate in the next rabi season under RYT.

Regional yield trial of chickpea

The evaluated genotypes were BCX 06002-6, BCX 06004-10, BCX 06001-11, ICCV-92944 and two checks as BARI Chola-5 and BARI Chola-9. ICCV-92944 took lowest mean minimum days to flower as well as it and BCX 06004-10 also matured earlier than the others. BCX 06004-10 was the tallest one and BARI Chola-5 was the dwarf one. Mean highest pods/plant was obtained from BCX 06004-10. Bold seeded entry was recorded as BARI Chola-9where BCX 06004-10 possessed the smaller sized seeds. Considering above all the stability parameters, yield contributing characters, and disease reaction it was revealed that BCX 06004-10 was the highest yielder genotype with moderate stability across the environments followed by BCX 06001-11and ICCV-92944. Therefore, three genotypes BCX 06004-10, BCX 06001-11and ICCV-92944 might be selected to evaluate in the next rabi season in PVS trial.

Chickpea international screening nursery- desi type

The entry ICCV-12110, ICCV-12114 and ICCV-12116 flowered early but none of them matured earlier than check BARI Chola-9. ICCV-12116 gave the highest pods per plant. The highest 100 seeds weight was found in ICCV-12117 followed by ICCV-12115 and ICCV-12110. Except check ICCV-12117 and ICCV-12115 produced better yield. Four entries e.g. ICCV-12117, ICCV-12115, ICCV-12110 and ICCV-12116 were selected on the basis of disease resistance, plant vigor, plant type, bold seeded and other desirable characters like yield potentiality which could be tested next year.

Chickpea international screening nursery- early type

All the test entries received from ICRISAT flowered earlier but only four of them matured earlier comparing with the two checks BARI Chola-5 and BARI Chola-9. The highest 100 seeds weight (38.37g) was found in ICCX-060156-33. No entry can out yield the check varieties. Finally four entries ICCX-060157-15, ICCX-0601557-3, ICCX-060157-11 and ICCX-060157-12 were selected on the basis of earliness, disease resistance and other desirable characters like yield potentiality for further evaluation in breeding trials.

Chickpea international BGM screening nursery

Six entries (ICCV-98801, ICCV-05529, ICCV-93706, ICCV-96207, ICCV-96830 and ICCV-97654) were selected on the basis of disease resistance, plant vigor, plant type, seed size and other desirable characters which will be tested next year under different breeding trials. The entries ICCV-98801 and ICCV-93706 will be tested under the observation trial to evaluate them as high yielding genotypes.

Chickpea international screening nursery-heat tolerance

Four entries like ICCV-07102, ICCV-07105, ICCV 07117 and ICCV 94954 were selected on the basis of yield, disease resistance, plant vigor, plant type, seed size and other desirable characters for further evaluation in breeding trials.

Chickpea international screening nursery-MABC (marker assisted back cross) trial

According to collaborative programs between BARI and ICRISAT, during season of 2014-15 Chickpea International Screening Nursery-MABC-2014-15, was conducted at PRC, Ishwardi, Pabna. Ten genotypes were evaluated along with check BARI Chola-9. Significant differences were observed in all studied characters. The highest yield was obtained from ICCMABCA-21 followed by ICCV-93954 and ICCMABCA-41. So, ICCMABCA-19, ICCV93954 and ICCMABCA-41were selected to evaluate in the next season.

Efficacy of fungicides in controlling botrytis gray mold (BGM) of chickpea

Five different fungicides viz- Karjet M8 (Simoxanil + Mancozeb), Sanoxanil 72WP (Simoxanil + Mancozeb), Euthen 80WP (Mancozeb), Indofil M48 (Mancozeb) andTijeb Gold 75WP (Mancozeb+Carbendazim) were evaluated under natural condition. Results revealed that Karjet M8 and Sanoxanil 72WP treated plots showed reduced disease severity against BGM.

Grasspea

Observation trail of grasspea germplasm

Earliness in days to maturity was observed in BARI Khesari-2 followed by IF-1337, IF-1348 and Sel-1348 and maximum days to maturity was observed in IF-1346 and Sel-1337. Highest pods per plant were found in Sel-1335 followed by IF-1337 and the lowest in Sel-1337 followed by Sel-1348. The highest yield was obtained from IF-1348 and lowest from Sel-1335. So, considering all the characters six genotypes IF-1348, Sel-1348, IF-1942, Sel-1337, IF-2606 and IF-1337were selected for PYT in the next year.

Evaluation of grasspea germplasm

The entry Patuakhali local matured earlier than others. Bold size seeds were obtained from BARI Khesari-2. The highest yield was obtained from BARI Khesari-3 followed by BKX-0008-1, BARI Khesari-2 and Patuakhali local. Lastly three genotypes BKX-0008-1, Patuakhali local and BKX-0002-4 were selected for futher evaluation in advanced breeding trials.

Mungbean

Hybridization and advancement of filial generations in mungbean

Hybridization programme on mungbean was conducted during Kharif-1, 2015 at PRC, Ishurdi, Pabna. Seven parents were used for hybridization and a total of 611 successful crossed seeds were collected from seventeen cross combinations. From F_1, F_2 F_3, F_4 and F_5 generation eight, three, five, seven and eighteen progenies were selected, respectively considering higher yield and other desirable traits.

Growing of F_2 generation of mungbean

Plant characters were investigated from seedling to harvest. Plants with desirable traits from the three of the F_2s were identified and selected comparing with checks and their seeds were harvested separately. Number of desirable segregating population was comparatively very low among the grown six F_2 progenies. So, for the retention of the large extent of variability, 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.

Growing of F_3 generation of mungbean

Finally plants with desirable characters were identified and selected comparing with checks on the basis of yield, disease resistance and other desirable attributes. Fifty seven single plants from five accessions were selected from the experimented accessions and 4-16 plants were selected from each entry. Each of the selected lines will be grown in F_4 generation in the next kharif-I season.

Growing F_4 generation of mungbean

On the basis of desired characters seventy nine single plants from seven lines were selected from the experimented accessions and 7-16 plants were selected from each entry. Seeds of each selected F_4 plants were collected and stored separately for further evaluation in the F_5 generation.

Growing F_5 generation of mungbean

A total of eighteen lines were selected from eight 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.

Observation trial of mungbean

Considering yield and yield contributing characteristics six genotypes IPM-02-03, BMXK1-09015-6, BMXK1-09012-1, BMXK1-09015-2, PM-5 and BMXK1-09015-1were selected for PYT in the next year.

Efficacy of herbicide on weed control in mungbean cultivation

The experiment was carried out at PRC, Ishurdi, Pabna and PRSS, BARI,Gazipur during kharif-1 season of 2015 to find out the suitable herbicide for economic weed control in mungbean cultivation in *Kharif-1* season. Nine treatments were used in experimental field. Among them three were pre-sowing of 3 herbicides, another three were post sowing of the same herbicides at 20 days after emergence (DAE), one hand weeding, one weed free and untreated control. Herbicides were Whip supper (Phenoxaprop-T- Ethyl) @ 1.5 ml L^{-1}, Relese (Phenoxaprop-T- Ethyl) @1.3 ml L^{-1} and Glycel (Glyphosate) @ 5 ml L^{-1}. The experiment was laid out in a RCB design with 3 replications. Mungbean variety, BARI Mung 6 was used. Seeds of mungbean @ 25 kg ha^{-1} were sown on 19 March 2015. Fertilizers were used @ N_{20} P_{40} K_{20} ha^{-1} as basal. Crop management practices such as thinning and plant protection measures were done as per requirement. Pre-sowing herbicide was applied 2 days before sowing of seed and post sowing was applied at 20 DAE. One spray of Imidachloprid (Imitaf 0.5ml/L water) was applied for controlling thrips. Weed was collected at 40 DAE and counted species wise and oven dried and weighed species wise. Pod was harvested on 16-28 May, 2015 at Ishurdi but Joydebpur crop was damaged due to heavy rain and hail storm during seedling stage of crop. Data on yield attributes were taken from 10 randomly selected plants per plot. The collected data were subjected to statistical analysis. Differences among treatment means were tested using R version 3.1.0 (2014-04-10).

Weed control efficiency was the highest (96%) in weed free but among the herbicides the highest efficiency of weed control (85%) was found in Release in post-sowing followed by Glycel 83% in post sowing treated plots and the lowest value (34%) was recorded in Glycel in pre sowing condition. The lowest intensity of weed infestation (IWI) 1.0 was found in Glycel post sowing followed by Relaes in post sowing condition and the highest IWI (5.0) was found in control plot. The highest seed yield (1340 kg ha^{-1}) was recorded from weed free followed by hand weeding (1300 Kg ha^{-1}) and the lowest seed yield (870 kg ha^{-1}) was obtained from control. The highest net return (Tk 20450/ha) was recorded from Hand weeding at 20 DAS plots followed by post sowing glycel, post sowing whip supper, weed free and post sowing release. But the highest monetary benefit (MBCR 5.2) come from Post sowing whipsupper plots followed by post sowing glycel, post sowing release and hand weeding at 20 DAS. Though the hand weeding offered the highest net return but its higher labour cost brought down the profit margin and showed lower MBCR. Appling Phenoxaprop-T- Ethyl (post sowing whipsupper) @ 1.5 ml/l of water gave highest benefit followed by glyphosate (post sowing glycel) and hand wedding at 20 DAS. Last year also the highest profit was obtained from post sowing whip supper treated plot.

Considering profitability in two years studies it could be concluded that Phenoxaprop-T- Ethyl (post sowing whipsupper) is the most profitable herbicide for controlling the broadleaf and grass weeds of mungbean followed by glyphosate (post sowing glycel) and hand wedding at 20 DAS.

Screening of mungbean lines resistant to MYMV and CLS

Twenty mungbean lines with a check BARI Mung 6 were evaluated in the trial. Results revealed that VC-6173, VC-3960A-88,BD-6911, BD-6922 and BD-6924 yielded lowest MYMV severity where BD-6913, BD-6918 and BD-6936 demonstrated lower CLS incidence.

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 2015. Thrips infested flower and thrips population were reduced significantly by installing white sticky trap + spraying of Chlorfenapyr (Intrepid 10 SC @ 1ml/l) and farmers practice i.e., spraying of Imidachloprid (Imitaf 20 SL @ 1 ml/l). Pod borer infestation was also reduced significantly by installing white sticky trap + spraying of Azadirachtin (Bio-neem plus 1EC @ 1ml/l) + spraying with Spinosad (Success 2.5 SC @ 1.25 ml/l), installing white sticky trap + spraying of Chlorfenapyr (Intrepid 10 SC @ 1 ml/l) + spraying with Emamectin Benzoate (Proclaim 5 SG @ 1 g/l) and also farmers practice i.e., spraying of Imidachloprid (Imitaf 20 SL @ 0.5 ml/l). 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 of Imidachloprid). 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 flower thrips and pod borer infestation. It could be profitable that areas where serious out break of flower thrips and pod borer occurs. Spraying of Imidachloprid (Imitaf 20 SL @ 0.5 ml/l) could be profitable in low to moderate level of thrips and pod borer infestation.

Cowpea

Evaluation and adaptation of cowpea genotypes in coastal area

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during *Rabi* season of 2014-15 to find out the suitable genotype(s) for better adaptation and higher yield of cowpea in southern coastal region of Bangladesh. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 2 rows x 2 m long. Fifteen advanced lines of cowpea along with one check (cv. BARI Felon-1) were evaluated in this trial. Seeds were sown on 26 November 2014. Of the plant characters, days to flowering, days to maturity, number of pod/plant, 100-seed weight and grain yield differed significantly due to variour types of genotypes of cowpea. The genotype CPS-7 and CPS-10 required the highest number of days to maturity (97 days) but the lowest time (90.5 days) required for CPS-2 and CPS-15. The check variety (BARI Felon-1) needed 94.5 days to become maturity. The highest number of pods/plant (10.18) was recorded in CPS-13 followed by CPS-12 (9.73) but the lowest number (5.33) was found in CPS-9. In case of grain yield, CPS-13 showed the highest (1982.19 kg/ha) followed by CPS-12 (1727.81 kg/ha). Yields of CPS-6, CPS-14 and CPS-9 were 1587.50, 1476.25 and 1332.81 kg/ha, respectively. The lowest yield (539.38 kg/ha) was obtained from CPS-11, whereas the check variety BARI Felon-1 gave the yield of 884.70 kg/ha. Results further revealed that increase of grain yield had the highest (124.05%) in CPS-13 followed by CPS-12 (95.30%) over the check variety BARI Felon-1. Besides, 79.44%, 66.86% and 50.65% yield increments were computed in CPS-6, CPS-14 and CPS-9, respectively. Considering the yield performance of the tested genotypes, CPS-13, CPS-12, CPS-6 and CPS-14 could be tested further in the next year (2015-16) for determining their yield potential.

4 OILSEED CROPS

Rapeseed and mustard (*Brassica* spp.)

Varietal Development

Development of convergent crosses in *Brassica rapa*

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 Joydebpur, Gazipur during rabi 2014-15. 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. Seeds were sown on 20 November 2014 at Joydebpur. Proper bagging was done to protect out crossing. Crossing was done through bud pollination by hand. Total ninety three plants were crossed from eight single cross combinations. Eight hundred and forty one siliquae, and three thousand six hundred and fifty eight seeds were obtained from different cross combinations. Crossed seeds were stored to develop three-way crosses in the next season.

Development of BC_2S_1 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 (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. Seeds of BC_2 were sown on 13 November 2014 at Joydebpur to develop BC_2S_1. Proper bagging was done to protect out crossing. Total 74 plants were selfed. Six hundred and twenty seven siliquae, and two thousand seven hundred and seventy seeds were obtained. Selfed seeds were stored to develop BC_2S_2 in the next season. Selfing was done through bud pollination.

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 350 selected plants were selfed from four source populations. Total 4608 buds were selfed from which 1564 effective siliquae and 5828 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines to grow as generation advancement in the next year.

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

Four double crosses were used in the crossing program to accumulate all the desired gene into a single parent. A total of 72% crosses were successful to produce siliquae and seeds. F_1 generation of single cross combinations were also advanced for F_2 generation.

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 seed. Eight brown sarrson parents and eight yellow sarson parents were utilized to produce single crosses from different developed varieties as well as advanced lines of rapeseed – mustard. The seeds of single crosses seed of the experiment were sown two times on 11 November and

18 November 2014 to synchronize the flowering for hybridization. In the 1st sowing of the experiment, the entries flowered on 12 December to 17 December 2014. In the 2nd sowing, the entries flowered on 17 December to 22 December 2014. The hybridization have been done with the following cross combinations, [(BARI Sarisha-6 x Sonali Sarisha) x (Tori-7 x BARI-Sarisha-12)], [(Jumka x BARI Sarisha-17) x (Din-2 x BC 2193)], [(BARI Sharisha-14 x BARI Sharisha-15) x (BARI Sharisha-9 x Kalyania)] and [(SAU-1 x BC-100614) x (BARI Sharisha-14 x S-6)]. Simultaneously single cross were advanced through bud crossing for F_2 generation. Inter cultural operations were done when necessary. Hybridization was started on 31 December 2014.

A total of 880 buds were crossed from which 630 siliquae were developed and 5106 seeds were produced. About 72% crosses were succeeded to produce siliquae and seed. F_1 seeds were stored for advancing different generations to collect desirable genotypes in future. F_1 generation of single cross combinations were also advancing for F_2 generation through bud crossing.

Confirmation of F_1 population of *Brassica rapa*

The F_1 seeds obtained from the 7 crosses made during 2014-2015 and parents were included in this trial. Three to five competitive plants randomly selected from each of the parents and F_1 s in each row for recording data on plant height (cm), siliquae per plant, seeds per siliqua, 100-seed weight (g) and days to maturity were recorded on plot basis. Among the crosses C-4 produced the highest hundred seed weight 0.208g. Seeds per siliqua was found the highest in the cross C-3 (33.04). Siliquae per plant was found highest in the cross C-3 (552.6). Based on the maturity, siliquae per plant and seed yield per plant the eleven crosses namely C-1,C-2, C-3, C-4, C-5, C-6 and C-7 were selected for growing F_2 generation in the next season.

Based on the maturity, seed size, siliquae per plant and seed yield per plant the seven crosses namely C-1, C-2, C-3, C-4, C-5, C-6 and C-7 could be selected for growing F_2 generation in the next season for further selection with desired characters.

Evaluation of segregating generations of *Brassica rapa*

Progenies of F_5 generation of fourteen cross combinations having both yellow and brown seed coat colour were evaluated. Progenies of F_6 generation (Set-I) of fifteen cross combinations having both yellow (one) and brown seed coat colour were evaluated. Progenies of F_6 generation (Set-II) of seven 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 coat colour, seed size and siliqua shape, disease and insect reaction. 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 fourteen cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2014-15 at Joydebpur. Progenies were sown following plant to progeny 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 20 November 2014. 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 fifteen cross combinations having both yellow (one) and brown seed coat colour were evaluated during rabi 2014-15 at Joydebpur. Progenies were sown following plant to progeny 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 20 November 2014. 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 seven cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2014-15 at Joydebpur. Progenies were sown following plant to progeny 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 20 November 2014. Single plant selection among progenies was done based on short duration (maturity duration up to 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_5 generation

Eighteen progenies having yellow seed coat colour from four cross combinations and thirty four progenies having brown seed coat colour from twelve 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 each progeny 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 yellow seed coat colour from one cross combination and progenies having brown seed coat colour from fourteen cross combinations were evaluated. Single plant selection method was followed. Considering earliness (maturity duration upto 88 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, progenies were selected or discarded. Thirty desirable plants were selected from four progenies and fourteen progenies were discarded. Seeds of selected plants were harvested seperately and stored for evaluation in Observation Trial in the next year.

F_6 generation (Set-II)

Forty nine progenies having yellow seed coat colour from four cross combinations and twenty one progenies having brown seed coat colour from three 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 each progeny and seeds of selected plants were bulked and stored for evaluation in the next year.

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

Seventeen lines of *Brassica rapa* having yellow flower and yellow seed coat colour were selected last year from F_6 generation of different cross combinations. These lines along with check as BARI Sarisha-14 were evaluated without replication under Observation Trial of *Brassica rapa* (Set-I) at Joydebpur during 2014-15. Variations were observed among the lines for all the characters studied. Maturity duration ranged from 85-93 days. BC-2014-01, BS -14 X BS-15-1 and check variety BARI Sarisha-14 were the earliest in maturity (85 days). Plant height ranged from 85-108 cm. The check variety BARI Sarisha-14 showed lowest plant height (85 cm). No. of siliquae/plant ranged from 42-174. No. of seeds/siliqua ranged from 13-29. The highest no. of seeds/siliqua recorded in BARI Sarisha-14. Thousand seed weight ranged from 3.32-4.59 g. Seed yield ranged from 1144-1726 kg/ha. The highest seed yield recorded in BS -14 X BS-15-2 (1726 kg/ha). Considering earliness, seed yield and other yield contributing characters, five lines BC-2014-Y01, BC-2014-Y02, BS -14 X BS-15-1, BC-2014-Y15 and BS -14 X BS-15-2 were selected for the next trial.

Twenty four lines of *Brassica rapa* having yellow flower and brown seed coat colour were selected last year from F_6 generation of different cross combinations. These lines along with one check as BARI Sarisha-9 were evaluated without replication under Observation Trial of *Brassica rapa* (Set-II) at Joydebpur during 2014-15. The lines were sown on 11 November 2014 in 3 rows of 3m long with spacing of 30 cm and 5cm between rows and plants, respectively. 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.

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

Eighteen lines of *Brassica rapa* having yellow seed coat colour along with BARI Sarisha-14 and Tori-7 as checks were evaluated at Joydebpur, Jessore and Ishurdi for yield and yield contributing characters. Significant variations were observed for plant height, no. of siliquae/plant and no. of seeds/siliqua. Maturity duration ranged from 84-88 days. Plant height ranged from 83-98 cm. The lowest plant height was recorded in BC-100614(4)-11. No. of siliquae/plant ranged from 46-113 which was highly significant. The highest no. of siliquae/plant was recorded in Tori-7. No. of seeds/siliqua ranged from 18-38. The highest no. of seeds/siliqua was recorded in BC-100614(8)-9 and BC-100614(4)-8 but lowest in check variety in Tori-7. Thousand seed weight ranged from 3.00-4.09 g. Seed yield ranged from 1090-1452 kg/ha which was non-significant.

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 82-88 days. Check variety Tori-7 was the earliest in maturity (82 days) over locations. It was observed the all of the genotypes matured earlier at Jessore location but matured in late at Ishurdi location. Seed yield ranged from 1271-1836 kg/ah over locations. The line BC-100614(4)-6 produced the highest seed yield over locations and it also produced the highest seed yield at Ishurdi location. Considering earliness, seed yield and other yield atributing characters, four lines like BC-100614(3)-5, BC-100614(8)-1, BC-100614(8)-7 and BC-100614(4)-6 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 BARI Sarisha-14 and Tori-7 as checks were evaluated at Joydebpur, Rahmathpur and Comilla for yield and yield contributing characters. All the characters studied showed significant variation except 1000-seed weight. Maturity duration ranged from 84-90 days. Line BC-110714(9)-5 was the earliest in maturity. Plant height ranged from 81-109 cm. The lowest plant height was recorded in BC-110714(7)-6. No. of siliquae/plant and no. of seeds/siliqua ranged from 61-203 and 12-24, respectively. The highest no. of siliquae/plant was recorded in BC -11219315(8)-2 and lowest in BC-100614(4)-19. The highest no. of seeds/plant was recorded in BC-110714(9)-5 and check variety BARI Sarisha-14. Thousand seed weight ranged from 3.00-4.09 g. Seed yield ranged from 1086-1913 kg/ha. The highest seed yield was recorded in BC-100614(4)-12 (1913 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 80-87 days. It was observed tha all of the genotypes matured earlier at Comilla location. Seed yield ranged from 1107-1661 kg/ah over locations. The line BC -11219315(8)-2 produced the highest seed yield over locations. Considering earliness, seed yield and other yield attributing characters, four lines like BC-110714(9)-5, BC-100614(4)-19, BC-110714(7)-3 and BC-110714(7)-6 were selected for RYT in the next year.

Regional yield trial of *Brassica rapa*

Seven advanced lines of *Brassica rapa* along with BARI Sarisha-14 and Tori-7 as checks were evaluated at Joydebpur, Ishurdi, Jamalpur, Jessore, Hathazari and Rahmathpur for seed yield and yield contributing characters in order to select line(s) for development of short duration variety of rapeseed. Significant variations were observed among the lines for all the characters studied. Maturity duration ranged from 84-88 days. Check varieties BARI Sarisha-14 and Tori-7 were earlier in maturity (84 days) followed by BC-100614(3)-1 (85 days). Rest of the lines took 87-88 days for maturity. Plant height ranged from 85-102 cm. The lowest plant height was recorded in BARI Sarisha-14. No. of siliquae/plant and no. of seeds/siliqua ranged from 66-164 and 17-30, respectively. The highest no. of siliquae/plant was recorded in Tori-7 which was statistically different with other genotypes. The highest no. of seeds/siliqua was recorded in BC-100614(3)-1 and BC-100614(8)-4. The lowest no. of seed/siliqua was recorded in Tori-7. Thousand seed weight ranged from 3.0-3.93 g. The highest thousand seed weight was recorded in BC-100614(4)-7 and the lowest in Tori-7. Seed yield ranged from 1112-1645 kg/ha. The highest seed yield was recorded in BC-100614(4)-9 and lowest in check Tori-7.

Aphid infestation/plant ranged from 70 to 77. Higher aphid infestation was found in all genotypes including check varieties. Two lines, BC-100614(4)-9 and BC-110714(7)-2 were found moderately resistant to *Alternaria* blight disesase. Three lines were moderately susceptible and one line susceptible. Check vareties BARI Sarisha-14 and Tori-7 were susceptible to *Alternaria* blight disesase. Considering earliness, seed yield and other yield atributing characters, two lines like BC-100614(3)-1 and BC-100614(4)-9 were selected for Adaptive Trial in the next year.

Confirmation of F_1 generation in B. *napus*

Seed from 6 cross combinations from B. *napus* were separately harvested and were bulked cross wise for growing F_2 generation.F_1 seeds were obtained from 6 cross combinations from B. *napus*. It was made during 2013-14 and was included in this trial. The seeds were sown on the 11.11.14. 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 data collection.

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*

Desirable populations on the basis of phenotypic performance, maturity, disease reaction, physical grain quality were selected for advancing the generation. Seeds of F_2-F_6 were sown on the 11th November, 2014. All seeds were space planted in 5m long double rows with 30 cm row spacing. Recommended fertilizers were applied and necessary steps were taken to grow the crop uniformly.

Observation trial of *Brassica napus*

An observation trial of Brassica *napus* was conducted with 85 genotypes at RARS Jamalpur during Rabi, 2014-2015 to evaluate the yield and yield contributing characters. F4 EW-06x Nap-0528 produced the highest yield among the genotypes. F4 EW-06x Nap-0546 and BARI-8xBARI-10 produced the second and third highest yield, respectively.

The results revealed that the highest yield was recorded from the genotype F4 EW-06x Nap-0528. It produced 2396 kg/ha yields which is 34.17% higher than check variety BARI Sharisa-8. It took 81 days to mature. The second highest yield was recorded from F4 EW-06x Nap-0546. It produced 16.42% higher yield than BARI Sarisha-8 and took 81 days to mature. The third highest yield was recorded from BARI Sarisha-8 x BARI Sarisha-10. It produced 2049 kg/ha yield and it was 14.74% higher than check variety. It only took 87 days to mature. These three lines produced higher yield and took 79-87 days to mature. These lines are suitable for growing in between Taman and Boro rice. There are some lines which produced higher yield than BARI Sarisha-8 and they became mature below 83 days. These lines may simultaneously be selected with the high yielding lines with early maturity for evaluation in preliminary yield in next year. F4 EW-06x Nap-0528, F4 EW-06x Nap-0546, BARI Sarisha-8 x BARI Sarisha-10 and those lines took below 83 days to mature and produced more than 1500kg/ha yield may be used in preliminary yield trial in next season.

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

Preliminary yield trial of Brassica *napus* was conducted with 15 genotypes at RARS Jamalpur and Oilseed Research Centre BARI, Joydebpur during rabi, 2014-2015 to evaluate the yield and yield contributing characters. Nap-14186 produced the highest yield among the genotypes included in this trial.

At RARS, Jamalpur, the highest grain yield was recorded from Nap-14086-2. It produced 1861 kg/ha grain yield which was 19.1%o than check variety BARI Sarisha-8. It took 85 days to mature. Primary branches, number of seed/pod were also high. The 2nd and 3rd highest yield was obtained from Nap-14186-1& Nap-14037. They produced 4.83% & 3.0% higher yield than existing *napus* variety BARI Sarisha-8. They took 79 days to mature. They had good number of seed/pod.

At Oilseed Research Centre BARI, Joydebpur, Nap-14186-1 produced the highest grain yield which was 2753 kg/ha. The second and third highest yield was recorded from Nap-14037 and Nap-14120. Over the two locations, it was observed from the average that Nap-14186-1 produced the highest yield, Nap-14186-1. Whereas, Nap 14086-2 and Nap-14037 produced second and third highest yield. Most of the lines included in this trial produced higher grain yield than check variety BARI Sarisha-8. Those lines took maximum 85 days to mature and produced more than 2000 kg/ha grain yield will be considered to be a good one. Those will be further evaluated under Regional yield trial in the next year. From the above results it can be concluded that Nap-14086-2, Nap-14186-1and Nap-14037 can be selected for regional yield trial on the basis of their seed yield per hectare and other traits.

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

Preliminary yield trial of Brassica *napus* (set-2) was conducted with 10 genotypes at RARS Jamalpur during rabi, 2014-2015 to evaluate the yield and yield contributing characters. Nap-14003 produced the highest yield among the genotypes included in this trial. It was laid out in randomized compete block design with three replications. BARI Sarisha-8 the released variety of *Brassica napus* was used as check. The plot size was 4 m x1.8 m. Data were taken on plant height, primary branches/plant, secondary branches/ plant, pod/plant, pod length, seed/pod, days to mature and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Thirteen genotypes of *Brassica napus* including BARI Sarisha-8 as a check were evaluated for yield and yield contributing characters. The highest grain yield was recorded from Nap- Nap-14003. It produced 1496 kg/ha grain yield which was 6.24%o than check variety BARI Sharisa-8. It took 79 days to mature. The 2nd and 3rd highest yield was obtained from Nap-14139& Nap-14129. They produced 3.66% & 2.87% higher yield than existing *napus* variety BARI Sharisa-8. They took 80-81 days to mature. From the above results it can be concluded that Nap-14003, Nap-14139 and Nap-14129 can be selected for regional yield trial on the basis of their seed yield per hectare and other traits.

Preliminary yield trial of *Brassica napus* (Set-III)

Preliminary yield trial of Brassica *napus* (set-3) was conducted with 10 genotypes at RARS Jamalpur during rabi, 2014-2015 to evaluate the yield and yield contributing characters. Nap-11022 produced the highest yield among the genotypes included in this trial. Thirteen genotypes of *Brassica napus* including BARI Sarisha-8 as a check were evaluated for yield and yield contributing charactersThe highest grain yield was recorded from Nap-11022. It produced 1758 kg/ha grain yield which was 7.2% than check variety BARI Sarisha-8. It took 82 days to mature. The 2nd and 3rd highest yield was obtained from Nap-10001& Nap-10002. They produced 4.8% & 4.6% higher yield than existing *napus* variety BARI Sarisha-8. They took 82-83 days to mature. From the above results it can be concluded that Nap-11022, Nap-10001and Nap-10002 can be selected for regional yield trial on the basis of their seed yield per hectare and other traits.

Regional yield trial of *Brassica napus*

A regional yield trial of Brassica *napus* L was conducted with 12 genotypes at RARS Jamalpur, Hathazari, Jessore,Ishurdi, Rahmatpur and Joydebpur during rabi 2014-2015; evaluation for yield and yield contributing characters.

Considering grain yield over the 6 locations, it was observed that Nap-10007 and Nap-1007 jointly produced the highest yield which was 6.15% higher than BARI Sarisha-8. The second highest yield was recorded from Nap-10005 and Nap-11008. Nap-10009 produced the third highest yield which was 3.24% higher than check.

Confirmation of F_1 generation of *Brassica juncea*

Among the crosses C-6 produced the highest hundred seed weight. Seeds per siliqua was found maximum in the cross C-3. Siliquae per plant was found highest in the cross C-3. The F_1 seeds from the crosses made during 2014-15 were included in this trial. The experiment was seeded on 11 November 2014 at Ishwardi.

Considering the 100 seed weight, siliquae/plant and days to maturity 10 crosses namely C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9 and C-10 were selected for growing F_2 generation in the next year.

Evaluation of segregating generation of *Brassica juncea*

Progenies of twelve 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 2014-15 at Joydebpur. Progenies were sown following progeny to row method along with BARI Sarisha-11 as check. Seeding of progenies was done on 24 November 2014 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.

Seventy eight progenies of three cross combinations having black/brown seed coat colour and 27 progenies of three cross combinations having yellow seed coat colour were evaluated .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 24 November 2014 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.

F_6 generation (Set-I)

Single plant selection method was followed. A total of 146 plants from twelve 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)

Single plant selection method was followed. A total of 78 progenies from three cross combinations having black/brown seed coat colour were evaluated and selected. Twenty seven progenies from two 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.

Preliminary yield trial of *Brassica juncea* L. (Set-I)

Twelve lines of Brassica juncea having yellow seed coat colour along with two checks as BARI Sarisha-11 and BARI Sarisha-16 were evaluated at Joydebpur, Ishurdi and Jessore. Days to maturity, no. of seeds/siliqua, thousand seed weight snd seed yield showed significant variation.

Regarding maturity duration over locations, days to maturity ranged from 104-106 days. Seed yield ranged from 1739-2545 kg/ha over locations. The highest seed yield was recorded in Bj-1111536(12)-3 over locations which also showed the highest seed yield at Jessore and Ishurdi locations. Considering seed yield and other yield contributing characters, four lines like Bj-1111536(12)-3, Bj-1111536(11)-1, BJ10-10104(Y) and Bj-1111536(9)-4 were selected for evaluation in RYT.

Preliminary yield trial of *Brassica juncea* L. (Set-II)

Thirteen lines of Brassica *juncea* having brown seed coat colour along with checks as BARI Sarisha-11 and BARI Sarisha-16 were evaluated at Joydebpur,Rahmathpur and Hathazari. Significant variations were observed for plant height, thousand seed weight and seed yield. Maturity duration ranged from 102-105 days. Plant height ranged from 124-164 cm. The highest plant height was recorded in BJ1018 (12)-6 and BJ-53611(15)-5 and lowest plant height recorded in BJ10-1011(B). No. of siliquae/plant ranged from 64-169. No. of seeds/siliqua ranged from 11-13. Thousand seed weight ranged from 2.35-3.68 g. The highest thousand seed weight was recorded in BJ-1153611(12)-1 which was statistically similar with check variety BARI Sarisha-16. Seed yield ranged from 1271-2340 kg/ha. The highest seed yield was recorded in check variety BARI Sarisha-16.

Considering locationwise seed yield and other yield contributing characters, four lines like BJ-53611(12)-8, BJ-111718(2)-4, BJ-111018(3)-12 and BJ1018(12)-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 Joydebpur, Jamalpur, Ishurdi, Jessore, Hathazari and Rahmatpur for yield and yield contributing characters.Maturity duration ranged from 103-106 days at Joydebpur location. Seed yield ranged from 1339-2210 kg/ha at Joydebpur location and BJDH-05 produced the highest seed yield. Maturity duration over locations ranged from 105-107 days. Seed yield ranged from 2058-2417 kg/ah over locations. BJDH-05 produced the highest seed yield followed by Bj-1111536(12)-5 over locations.

Regarding maturity duration over locations, days to maturity ranged from 105-107 days. Seed yield ranged from 2058-2417 kg/ah over locations. The line BJDH-05 produced the highest seed yield (2417 kg/ha) followed by Bj-1111536(12)-5 (2409 kg/ha) over locations.

Aphid infestation/plant ranged from 10 to 29. Highest aphid infestation/plant was found in Bj-1111536(7)-1 and lowest in BJDH-05. Five tested lines and BARI Sarisha-16 were found moderately resistant to *Alternaria* blight disesase. One tested line showed moderately susceptibe and one line showed susceptible reaction to *Alternaria* blight disesase. BARI Sarisha-11 was found resistant to *Alternaria* blight disesase. Considering location wise seed yield and other yield contributing characters, three lines BJDH-05, Bj-1111536(12)-5 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 made to incorporating desirable characters from species into a genotype. Maximum success of back cross shown in BC_2 [(B. carinata x BARI Sarisha 13) x BARI Sarisha-13] followed by BC_2 [(Tori-7 x *B. carinata*) x Tori-7]. The overall back cross (BC_2) success in interspecific hybridization were 56%. Eight cross combinations of interspecific hybridizations were used in the experiment. Seeds of different samples were sown on 11 November 2014. *B. carinata* was late in flowering while the *B. rapa* and *B. napus* varieties were early flowering.

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

The experiment consisted of three CMS lines like CMSZ_1 (248), 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 2014-15. Seeding was done on 20 November 2014. 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.

Days to flowering and maturity for CMS lines ranged from 24-27 days and 105-120 days, respectively. In total 908 buds of 34 plants of three CMS lines were crossed with two maintainer lines. Five thousand two hundred and fifty one seeds were obtained from 651 siliquae. Seeds were stored for future breeding programme.

Days to flowering and maturity for Nap-248M and Nap-279M were 26 and 108 days, respectively. Flowering and maturity duration for Nap-14-01R were 32 and 123 days, respectively. Five thousand four hundred and forty eight buds were selfed from 126 plants. In total 23647 seeds were obtained from 4178 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_1 population were selfed for advancing S_2 generation. Two thousand five hundred and eight buds were selfed and 2338 siliquae were obtained from which 32845 seeds were obtained in Golden Sapphire. Two thousand three hundred and thirty two buds were selfed and 1896 siliquae were obtained from which 27341 seeds were obtained in Yunyouzaerhao-2 and Yunyouzaerhae-10. Seeds were stored for advancing S_2 generation. CMS plants were identified in Yunyouzaerhao-2 and Yunyouzaerhae-10 and crossed with selected pollen fertile plants and male parent were selfed. It was observed that pollen fertile plants ranged from 44-75% and CMS plants ranged from 25-56%. CMS lines were crossed with restorer line to develop test crosses. CMS lines were also crossed with short duration *Brassica napus* lines and varieties, and restorer line was crossed with *Brassica napus* lines and varieties to develop short duration parental lines. Ogura CMS plants were back crossed with short duration *Brassica napus* lines for introgression of CMS into *B. napus* lines.

Development of test crosses in *Brassica napus* L.

Three CMS lines [CMSZ_1(248), CMSY_2 and CMSY_{10} and one Restorer line (Nap-14-01R) were used as experimental materials. The experiment was conducted during rabi 2014-15 at Gazipur. Seeds were sown on 24 November 2014. CMS lines were crossed with restorer line and restorer line was selfed. Bagging was done to protect out crossing. Crossing was done by hand pollination.

Eight CMS plants were selected from CMSZ_1 (248) line and eight plants were also selected from restorer line and crossed between them. One hundred thirty eight buds were crossed and 79 siliquae were obtained from which 831 seeds were obtained. Simultaneously, 493 buds of eight restorer plants were selfed and 384 siliquae were obtained from which 3534 seeds were obtained.

Four CMS plants were selected from CMSY_2 line and four plants were also selected from restorer line and crossed between them. Eighty four buds were crossed and 53 siliquae were obtained from which 522 seeds were obtained. Simultaneously, 152 buds of four restorer plants were selfed and 110 siliquae were obtained from which 1102 seeds were obtained.

Three CMS plants were selected from CMSY_{10} line and four plants were also selected from restorer line and crossed between them. Fifty nine buds were crossed and 34 siliquae were obtained from which 337 seeds were obtained. Simultaneously, 97 buds of four restorer plants were selfed and 59 siliquae were obtained from which 572 seeds were obtained. Seeds were stored for evaluation of test crosses in the next year.

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 2014-15 at Gazipur. Seeds were sown on 24 November 2014. 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.

Results on crossing between CMS lines and short duration *Brassica napus* lines/varieties are presented in Table 41. Days to maturity for CMS lines ranged from 100-104 and for *Brassica napus* lines/varieties ranged from 87-95 days. One thousand four hundred and eighty three buds of 101 CMS plants were crossed with short duration *Brassica napus* lines/varieties. Seven hundred and sixty six siliquae was obtained from which 6826 seeds were obtained. Seeds were stored for back crossing in the next year.

Days to maturity for restorer line was 123 days and for *Brassica napus* varieties/lines ranged from 93-95 days. One thousand and eighty two buds of 291 restorer plants were crossed with short duration *Brassica napus* varieties/lines. Four hundred and fifty seven siliquae was obtained from which 3997 seeds were obtained. Seeds were stored for back crossing in the next year.

Introgression of ogura cms into *Brassica napus* L. lines

Ogura CMS and three short duration (87-88 days) *Brassica napus* lines, Nap-0876, Nap-0869 and Nap-205 were used as experimental materials. The experiment was conducted during rabi 2014-15 at Gazipur. Ogura CMS plants were identified from S$_1$ population and crossed with three short duration *B. napus* lines during last rabi 2013-14 and F$_1$ seeds were obtained. F$_1$ seeds were sown on 24 November 2014 and F$_1$ population were grown. CMS plants were identified from F$_1$ population and back crossed with short duration *Brassica napus* lines.

Moreover, some ogura CMS plants were identified from S$_1$ population during last rabi 2013-14 and crossed with selected pollen fertile plants (male parent). Selected pollen fertile plants (male parent) were also selfed. F$_1$ seeds (CMS x male parent) and selfed seed (male parent) were sown side by side on 24 November 2014. 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 identified and again crossed with selected pollen fertile plants (male parent) and pollen fertile plants (male parent) were again selfed. Bagging was done to protect out crossing. Crossing and selfing were done by hand pollination.

Five hundred and fifty six buds of 14 Ogura CMS plants were crossed with short duration *Brassica napus* lines. One hundred and thirty six siliquae was obtained from which 834 seeds were obtained. Seeds were stored for back crossing in the next year. Results on F$_1$ population in crossing between ogura CMS plants and selected pollen fertile plants (male parent) and selfing of male parent are presented in Table 44. Pollen fertile plants ranged from 75-100%. Ogura CMS plants ranged from 17-25%. Eight hundred and ten buds of 23 plants were selfed. Two hundred and sixty five siliquae were obtained from which 818 seeds were obtained. Seeds were stored for growing in the next year.

Identification of early restorer genes in *Brassica napus*

An attempt has been taken for hybrid production in *B. napus*. The parental lines A and B were synchronumous for flowering while the R line was very late. Backcrossing was done to incorporate earliness. Effort also has been taken to transfer Ogura CMS source into the existing *B. napus* varieties. Positive heterosis has been found in most of the desirable characters using newly developed R lines

(BC_1).The experiment was conducted using four BC_1, 7 F_1 and 2 hybrid (developed with BC_1 restorer) with their respective parents. The F_1 generation was advanced for F_2 through bud selfing and BC_2 was also done with respective parents to incorporate early genes into the collected late restorer. Heterosis study also done with new developed early restorer (BC_1). Effort also has been taken to transfer Ogura CMS source to the existing *B. napus* varieties.

Original restorer (R) is very late both in flowering (55 days) and maturity (150 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 (108- 112 days) respectively almost synchronize with the A and B lines.The BC_1 restorer were advanced in BC_2 with the respective parents. A total of 636 buds were crossed from which 463 siliquae developed and 7162 seeds produced from different cross combination. Average success of the different cross combinations were 73%.

Different CMS lines along with B line have been maintained with the bud crossing and bud selfing respectively. A total of 567 buds were crossed from which 450 siliquae developed and 5345 seeds produced. Average success of the different cross combination was 79%.Effort of transferring Ogura CMS system into the existing varieties has been made .A total of 111 buds were crossed from which 23 siliquae developed and 53 seeds produced. Average success of the different cross combination was 21%.

The CMS lines were crossed with newly developed restorer (BC_1) to know the performance of the hybrid. Heterosis of most of the desirable characters like no. of seeds, no. of pods/plant and yield/plant were high. The hybrid (CMSZ1x R1) showed the maximum heterosis for no. of pods/plant followed by yield/plant while the hybrid (CMSZ1 x R2) in yield/plant followed by pods/plant.

Observation trial of of double low genotypes of *Brassica napus*

Fifteen genotypes of Brassica *napus* along with BARI Sarisha-13 as check were evaluated to know the performance of the genotypes. Fatty acid composition of these genotypes was also determined to identify low erucic acid genotypes. Linolenic acid (ω-3) ranged from 7.63 to 12.13%. Erucic acid ranged from 0.07 to 39.62%. The highest erucic acid was recorded in check variety BARI Sarisha-13. Maturity duration ranged from 89-98 days. Seed yield ranged from 1722-2796 kg/ha. The highest seed yield recorded in Nap-14-003 (2796 kg/ha). Considering low erucic acid (less than 2%) and other essential fatty acids, seed yield and yield contributing characters, five genotypes like Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011 were selected for evaluation in the next trial.

Crop management

Performance of selected mustard genotypes under salinity condition in pot culture

The experiment was conducted at net house of Oilseed Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. Nine selected mustard genotypes (Nap-0564, Nap-0567, BARISarisha-8, BARISarisha-10, BARISarisha-11, BARISarisha-16, SAU-01, Jun-536 &, BJDH-12) screened in laboratory under hoagland nutrient solution culture were used in the study at 0,4,8, and 12 dS/m of NaCl solution. Seeds of each genotype were sown in each pot on 14 November 2014. The days to first flowering was increased with the increase of salinity levels for all the nine genotypes of mustard later at salinity level of 12 dS/m. From the result it can be concluded that BARI Sarisha-16, BJDH-12, Jun-536, BARI Sarisha-10, BARI Sarisha-11and SAU-01 are more salt tolerant than the other genotypes.

Screening of mustard genotypes for drought tolerance at flowering stage

The experiment was conducted in pot under semi controlled condition at net house of Oilseed Research Centre of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2014-15. Thirty rapeseed-mustard varieties and genotypes were used for screening of drought tolerance at flowering stage.Two set treatments were maintained. One set was maintained under 100 percent field capacity (non stress) throughout the growing period and another set was maintained under 50 percent field capacity (stress) throughout the growing period. Soil moisture was measured by soil moisture meter (Model –TDR 200). Drought was imposed by restricting irrigation and plants were re-irrigated when they showed signs of wilting or leaf rolling. After germination, excess plants were removed to maintain five plants in each pot. The genotypes were harvested at maturity. Data were collected on days to flowering, maturity, yield contributing characters, yield/plant, total dry matter weight. TDW per plant, Relative yield / yield stability (RY/YS) and drymatter stress index (DMSI).Volumetric soil moisture content changes with time appreciably depending on the treatment. Drought stress showed remarkable influence on leaf area and total drymatter weight of mustard regardless of treatments. Leaf area is increasing with increase plant age upto 40 DAE thereafter slightly decrease. Thirty genotypes were collected and screened against drought in a pot experiment. Based on plant growth, yield and yield attributes and drought susceptibility the genotypes were evaluated. Most of the genotypes were found susceptible to drought and only a few were found drought tolerant to some extent. From the preliminary screening study, nine genotypes; BARI Sarisha-6, BJDH-05, BC-9922, BARI Sarisha-11, Nap- 0546, Nap- 0564, BJDH-12, BC-9921 and BC-9917 were selected for drought tolerant group at flowering stage. The rest of the genotypes are susceptible class.

Screening of mustard genotypes against salinity

The experiment was conducted during the period from November, 2014 to May 2015 at net house of oilseed research centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. Seeds of sixty seven genotypes of mustard were collected from PGRC, BARI, Joydebpur. Gazipur. Four NaCl concentrations viz. 0 (control), 4, 8 and 12 dS/m and 42 genotypes were used as treatment variables, The salt solution was prepared by calculating amount of NaCl in distilled water, Hongland solution was used as nutrient media with the salt solution, The p^H of Hongland solution was maintained 6-7. Plastic pots were used in the experiment with a diameter of 10 cm and arranged in a completely randomized design (CRD) with three replications. Seed were sown on the plastic pots having blotingpaper, The germination count was started after 72 hours of sowing and continued till the 13^{th} day. A seed was considered to have germinated when both the plumule and the radicle emerged>0.5cm. The results revealed that there were significant reduction in root length with increased salinity level. Incase of 12dS/m salinity level, the highest seedling root length (9.95cm) was found in genotype BD-6950 and which was followed by BD-6953(9.66cm),BD-7105(9.53 cm) and BD-7102 (9.44 cm). The highest seedling relative root length (77.26) was found in genotype BD-7129 and which was followed by BD-7113(69.89). All genotypes of mustard gave maximum shoot length at 4 dS/m followed by 8dS/m respectively. The genotypes BD-6950, BD-6951, BD-6952, BD-6953, BD-6954, BD-6957, BD-6958,BD-7102,BD-7105,BD-7108,BD-7113,BD-10110 and BD-10115performed better at 12dS/m.

Performance of mustard varieties in the hilly valley areas of Khagrachari

The study was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari during the period from November 2014 to February 2015. The trial was laid out in a randomized complete design with three replications. Five mustard varieties viz. Improved Tori-7, BARI Sarisha-14, BARI Sarasha-15, BARI Sarisha-16, and BJDH01 were included in the study. Seeds were sown on 18 November 2014 @ 8 kg ha^{-1} in solid line with 40 cm row spacing. The unit plot size was 3m x 4m. Fertilizers @ 120-80-60-40-4-1 kg/ha N, P_2O_5, K_2O, S, Zn and B respectively were applied in the form of Urea, Triple super phosphate (TSP), Muriate of potash (MOP), Gypsum, Zinc sulphate and Boric acid respectively. Half of N and all other fertilizers were applied as basal and the remaining N was applied before flowering at 20 days after sowing. Other intercultural operations such as weeding, thinning, irrigation, pesticide application were done as and when required. The variety variety Tori-7 showed the lower yield. The genotype BJDH-01 showed highest seed yield and BARI

Sarisha-16 showed the second highest yield due to siliqua/plant with crop duration 90 days. The trial is needed for another year for confirmation.

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

The field experiment was conducted at the Central Research Station of BARI Joydebpur (AEZ 28) during 2014-2015 (July 2014 through June 2015). Six cropping patterns were as follows:CP_1 = T. Aman (var. BINAdhan7) – Mustard (var. BARISarisha-16) – Mungbean (var.BARI Mung-6) – T. Aus (var. Parij), CP_2 = T. Aman (var. BRRI dhan 62) – Garden pea (var. BARI Motorsuti-3)– Boro (var. BRRI dhan-28) -T. Aus (var. Paria), CP_3= T. Aman (var. BRRIdhan57)– Cowpea (var. BARI Felon-1)– Sesame (var. BARITil-4) –Radish(var. BARIMula-1), CP_4 = T. Aman (var. BRRIdhan 62) – G.nut (var. BARIChinabadam-8) + Garlic (var. BARIRashun-1)–T.Aus (var.BRRIdhan48), CP_5=T.Aman (var.BRRIdhan62)– Groundnut (var.BARIChinabadam-8)+ Onion (var. local) –T. Aus (var. Parija) and CP_6 = T. aman (var. BINAdhan7) – Fallow – Boro (var. BRRIdhan28) – Fallow (Control). The experiment was laid out in a Randomized Complete Block (RCB) design with 4 replications. The unit plot size was 6m x 4m. Transplanted aman (T.aman) (BINA dhan 7), BRRI Dhan-62, BRRI Dhan-57 were grown during the Kharif II season and it was the first crop of the sequence. 25 days old seedling were transplanted with 20cm x 15cm spacing on 24 July, 2014. Rice was harvested at 30 cm height from soil surface and remain part of the rice plant was incorporated with soil. Grain yield and straw yield were taken from whole plot. Mustard was grown during rabi season. BARI Sarisha-16 was planted with 30 cm x 5 cm spacing on 5 November, 2014. BARI Sarisha-16 was harvested on 25 February, 2015. Seed yield and straw yield were taken from whole plot. Mungbean was grown during Kharif-I season. Mungbean (cv. BARI mung-6) were sown on 01 March, 2015. Mungbean were harvested on 07 May, 2015. Grain yield of mungbean and biomass weight of mungbean were taken from entire plot. After harvesting of pods, mungbean plants incorporated into the soil. As per treatment gardenpea was grown during rabi season. Garden pea (cv. BARIMotorsuti-3) were planted with 30 cm x 5 cm spacing on 5 November, 2014. Garden pea (cv. BARIMotorsuti-3) was harvested on 18 January 2015. Garden pea was picking at 60 DAE and foliage (over dry) weight were taken from whole plot. Boro was third crop of the sequence. Fourty five days old seedling of BRRI dhan 28 were transplanted with 20cm x 15cm spacing on 25 January, 2015 in CP_2; Boro rice were harvested on 4 May, CP_2. Boro rice were harvested on 4 May, 2015 in CP_2.. Rice was harvested at 30 cm height from soil surface and remain part of the rice plant was incorporated with soil. Grain yield and straw yield were taken from whole plot. Sesame was grown during Kharif-I season. Sesame (cv. BARITil-4) was sown on 08 March, 2015. Sesame was harvested on 04 June, 2015. Grain yield of Sesame and biomass weight of sesame were taken from entire plot. After harvesting of capsules, sesame plants incorporated into the soil. Radish was grown during Kharif-II season. Radish (cv. BARImula2) was sown on 08 March, 2015. Radish was harvested on 27 July, 2015. Vegetable yield ofvegetable and biomass weight of radish were taken from entire plot. Transplanted aus (T.aus) rice was forth crop of the sequence. Twenty-day aged seedling of Parija and BRRIdhan 48 were transplanted with 15cm x 15cm spacing on 10 May in CP_1, CP_2 , and CP_4. T. aus was harvested on 21 July in CP_1, CP_2 and 23July in CP_4. Rice was harvested at 30 cm height from soil surface and remain part of the rice plant was incorporated with soil. Grain yield and straw yield were taken from whole plot. During 2014-15, in case of CP_1, grain yields of T. aman was 4.73t/ha. Seed yield of mustard (var: BARI Sarisha-16) was 1.92 t/ha mungbean 1.10 t/ha; T. aus was 2.50 t /ha respectively. In case of CP_2, grain yields of T. aman was 4.58 t/ha. Pod yield of gardenpea was 4.95 t/ha. Grain yields of Boro was 5.62 t, t/ha; T. aus was 2.50t/ha. Grain yield of T. aman was 4.7 t/ha, seed yield of cowpea was 1.56 t/ha, sesame was 1.09t/ha was 1.55 t/ha and; vegetable yield of radish was 3.0 t/ha, in case of CP_3. Grain yield of T. aman was 4.38 t/ha, nut yield of groundnut was 1.73 t/ha, bulb yield of garlic was 2.20 t/ha and; T. aus was 2.50t/ha, in case of CP_4 .In case of CP_5, grain yield of T. aman was 4.51 t/ha, nut yield of groundnut was 1.66 t/ha, bulb yield of onion was 7.20 t/ha and; T. aus was 2.64t/ha. Grain yield of T. aman was 4.9 t/ha, grain yield of Boro was 5.7t/ha in case of CP_6. The highest REY (30.25 t/ha) was recorded from the cropping sequence T. aman – groundnut – Onion – T.aus (CP_5) followed by T. aman–Gardenpea– Boro –T. aus (CP_2) (29.15 t/ha). The lowest REY (13.07 t/ha) was obtained from the cropping sequence T. aman – Fallow – Boro – Fallow. Inclusion of groundnut+ onion and gardenpea during rabi season in CP_2 and CP_5 increased REY 123% to131.4% compared to farmer's pattern CP_6. The highest gross margin was obtained from cropping pattern 5 (Tk 343558 /ha) followed by cropping pattern2 (Tk 327389/ha), cropping pattern 4 (Tk.255610/ ha). Cropping pattern 6 gave the lowest gross margin (Tk.105855/ha). The highest MBCR was found in cropping pattern 5 (4.12) followed by cropping pattern 2 (3.98), cropping pattern4 (3.01). Farmer's pattern (control) CP_6 gave the lowest MBCR (2.17) during 2014-15. From the above result showed that that five cropping pattern: CP_1 = T. Aman (var. BINAdhan7) – Mustard (var. BARISarisha-16) – Mungbean (var.BARIMung-6) – T. Aus (var. Parij), CP_2 = T. Aman (var. BRRIdhan 62) – Garden pea (var. BARIMotorsuti-3) – Boro (var. BRRIdhan-28) -T. Aus (var. Paria), CP_3= T. Aman (var. BRRIdhan57) –Cowpea (var. BARIFelon-1) –Sesame (var. BARITil-4) – Radish (var. BARIMula-1), CP_4 = T. Aman (var. BRRIdhan62) – G.nut (var. BARIChinabadam-8) + garlic (var. BARIRosun-1)– T. Aus (var. BRRIdhan-48),CP_5= T. Aman (var.BRRIdhan62) – G.nut (var.BARIChinabadam-8)+ onion (var. local) –T. Aus (var. Parija) also showed reasonable benefit and short duration varieties of different crops could be easily fitted in the existing pattern without deteriorating soil nutrient system.

Pest management

Screening of rapeseed-mustard varieties/lines against alternaria blight

The experiment was conducted at Oilseed Research Centre, BARI, Joydebpur during rabi 2014-2015 cropping season to findout the resistant lines of rapeseed-mustard against Alternaria blight. Thirty one (31) lines of different Brassica spp (*B. campestris, B. napus and B. juncea*) were used in the study. Seeds were sown on 18 November 2014 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 Seventeen lines(NAP-10015,NAP-1005, NAP-10014 , NAP-10012- 1, BARI Sarisha 13, NAP-11008, NAP-10019, BC-05115, BC-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. were found moderately resistant reaction and only four lines (Nap-10017, Nap-205, BJ-66(y) and BARI Sarisha 11) were found resistant to the disease. 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, Ishwardi, Pabna during 2014-2015 to findout the resistant lines of rapeseed-mustard against Orobanche. Among the 31 mustard lines, eight lines viz. BARI-11, Nap-0717-2, Nap-0837, BC-100614(4)-7, BC-100614-8-2, BC-100614-4-17, BC-100614-4-2 and BC-100614(4)-5 showed resistant reaction, 11 lines showed moderately resistant reaction and rest 12 lines including check showed susceptible reaction against Orobanche.

Study of fungicides against white mold disease of mustard

The experiment was conducted at the Regional Agricultural Research Station, Ishwardi, Pabna during rabi season 2014-2015 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. The spacing was 30 cm x 5 cm. 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 (2.72%) was found in Folicur 250 EC (2ml/l) treated plots which are statistically close to Rovral 50 WP (2.87%) trated plots where as the highest (10.30%) was recorded in control plots. Folicur 250 EC (2ml/l) treated plots gave the highest yield (2.17t/ha).

From the above experimental results, it may be concluded that Folicur 250 EC (2ml/l) and Rovral 50 WP (2g/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.

Effect of pre-sowing seed treatment along with single foliar spray of fungicides to control alternaria blight of rapeseed-mustard

The study was conducted at ORC Gazipur, during 2014-2015 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 = Rovral spray (55 DAS) single ,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 (g) 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 (24.96%) with the highest yield (1624kg/ha) was obtained from recommended Rovral sprayed plot .The second highest yield (1544kg/ha) and lowest disease incidence (26.13%) were obtained from seed treatment with Provax with single spray of Rovral at 55 DAS. The highest disease incidence (69.99%) and lowest yield (1053 kg/ha) were recorded from control plot. From the result of the experiment it may be concluded that seed treatment with Provax with single spray of Rovral at 55 DAS could effectively control the Alternaria leaf blight disease incidence and increasing the yield of mustard.

Development of disease resistant, lea (low erucic acid) quality BARI Sarisha-14 through marker-assisted backcrossing

Short duration Brassica rapa cultivating in the country has no low erucic acid (LEA) cultivars. In order to develop low erucic acid mustard cultivars, high erucic acid (HEA) mustard cultivars were inter specifically crossed as recurrent parents to a canola quality rapeseed. In the advance backcross homozygous e1e1 type lines were developed through marker assisted selection. Fatty acid composition in seeds revealed very low erucic acid (0.3 - 0.8%), high oleic (53.0 - 67.9%), and moderate linoleic (9.7 - 17.8%) acid contents, which belong to the zero erucic acid class. Developed line also contained Fusarium wilt resistant loci as well as short duration quality. Others yield contributing characters also found satisfactory in some advance lines compare to cultivated short duration B. rapa, BARI sarisha-14. So, promising lines will contribute to Fusarium resistant, Low erucic acid (LEA) quality short duration rapeseed breeding.

Evaluation of short duration, disease resistant resynthesized *B. napus* under Bangladesh environmental condition

Brassica napus is a leading high yielding oilseed crop throughout the world but it requires longer time to harvest that is hard to manage in mustard-rice cropping pattern of Bangladesh. Biotic agents like

Fusarium yellows affect reducing crop yield and may more severely attack plants by increasing global warming. To overcome such problems, in this study, short duration B. napus plants were resynthesized using Fusarium resistant B. rapa parents. Fusarium wilt resistant loci were confirmed in five RS B. napus and one SRS B. napus. In RS F5 generations first flowering, maturity and yield were similar to cultivated BARI sarisha-7 and BARI sarisha-8. The RS F2, AlBA-16 × TCr-3 lines showed highest yield potentiality (56% higher yield) with similar maturity (107.7 DAS) compare to BARI sarisha-7. So, RS and SRS B. napus lines could potentially be used for short duration, Fusarium resistant B. napus breeding. In that regard, the successive selection with appropriate balance of the two important traits (earliness and yield) with resistant allele will be required in subsequent generations.

Screening of rapeseed & 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 2014-15 at Gazipur. Three entries of B. rapa, namely BC-05115, BC-9921, BC-05117 (25-30 aphids/plant) and of B. juncea BJDH-01, BJDH-12 (6.65 -7 aphids/plant) were found comparatively less aphid infestation than the check and other entries. From the result of this experiments, it was observed that B. rapa entries were attacked by the highest number of aphid while B. juncea had the lowest aphid infestation.

Role of honey bee on the yield and yield contributing characteristics of BARI Sarisha-14

The experiment was conducted in the field of Oilseed Research Centre, Bangladesh Agricultural Research Institute Joydebpur, Gazipur during rabi 2014-15.This investigation consists of the experiment i.e. impact of bee pollination on the yield and yield components of rapeseed variety BARI Sarisha-14. In bee pollinated (BP) plants the number of pods per plant, number of seeds per pod, weight of 1000 seeds (g) and yield/ ha were about 19.85%, 15.25%, 7.42% and 13.55% higher than naturally pollinated (NP) plants respectively. Without pollinators the number of pods per plant, number of seeds per pod, weight of 1000 seeds (g) and yield/ ha were about 17.54%, 30.58% , 4.41% and 33.08% lower than naturally pollinated (NP) plants respectively. Bee pollination is most effective and cheaper device for seed production rapeseed and mustard.

Post Harvest and Biochemical Studies

Separation and Identification of Glucosinolates of rapeseed-mustard seeds by HPLC method

Glucosinolates (GSLs) are biologically active secondary metabolites of the Brassicaceae and related plant families that influence plant interactions. Numerous laboratories, all over the world, use now this method, especially in order to control the “00 or canola” varieties. The purpose of this study was to estimate individual and total glucosinolate content in the rapeseed-mustard seeds. The major GSLs are sinigrin, 4-hydroxyglucobrassicin, glucoraphanin, progoitrin, gluconapin, glucobrassicanapin and glucobrassicin. Two GSLs peaks were identified in three cultivars of rapeseed-mustard. The identified GSLs consisted of two alkenyl GSLs (sinigrin and gluconapin). Among them sinigrin is generally found in significant amounts in rapeseed. It is commonly used as an external or internal standard. These parameters, glucosinolate profile, could be taken into consideration by oilseed rape breeders as selection criteria for developing genotypes with modified seed quality traits in B. napus L.

Low erucic acid and high Omega-3, Omega-6 and Omega-9 fatty acid content in some rapeseed-mustard cultivars developed in Bangladesh

Rapeseed-mustard is one of the most economically important oilseed crops in Bangladesh. Sixteen lines of rapeseed-mustard including two checks as BARI Sarisha 13 and BARI Sarisha 14 were characterized for their fatty acid composition. It is essential to estimate the fatty acid composition of existing advance lines and varieties of rapeseed. Erucic acid was one of the main fatty acids in proportion ranging 0.08-51.16% followed by omega-9/oleic acid ranging from 12.63-62.39%. The major polyunsaturated fatty acids were omega-6/linoleic and omega-3/linolenic acid, ranging from 12.79-25.67% and 7.63-11.80%, respectively. The rapeseed-mustard 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 erucic acid and high levels of omega-3, omega-6 and omega-9 fatty acids than BARI Sarisha 13 and BARI Sarisha 14. These six advanced lines may be exploited in breeding programs 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 nineteen (119) 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 2014.

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 2014 and 11 January 2015 at Joydebpur 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 have 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 418 buds were pollinated. On an average 13% crosses were successful and produced 53 pods. The percent of success is low due to the drought prevailing at flowering stage and excessive rainfall occurred during pod filling stage.The pollinated pods will be grown in the next rabi season for F_1 confirmation.

Evaluation of segregating generations of groundnut

Seeds of nine combinations from F_1, thirty from F_3 and four from F_5 segregating generations, respectively were sown on December 31, 2014 at Joydebpur for advancing the generations. 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.

On the basis of number of mature pods per plant, cluster pod formation, dwarf canopy of the plant, pod surface and diseases and insect reaction, a total of 3, 73 and 19 single plants were selected from F_1, F_3 and F_5 generations, respectively. The seeds from selected single plant of F_1 was collected and stored for advancing the generations as F_2 in the next season. On the other hand the seeds from F_3 were bulked according to the cross and generation will be advanced as F_4 generation. From the F_5 generation 19 plants were bulked from 4 accessions and will be tested their performance as F_6 generation trial 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 2014-2015. Seeds of the entries were sown on December 29, 2014 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.

Statistically significant difference was observed among the varieties for all the characters. Days to maturity of all the genotypes differ statistically than that of the the check variety Dhaka-1. The genotype NCGV 98383 was most dwarf entry (33 cm) compared the check Dhaka-1(51 cm). Maximum shelling per cent were found in the genotypes NCGV0204, NCGV 0504 and 14-303 (70%). Highest pod yield of 3294 kg/ha was obtained from the genotype NCGV 04096 followed by the genotype NCGV0204 (2841 kg/ha) which were 64% and 42% higher than the HYV BARI Chinabadam-8. Considering the per hectare yield and shelling percentage, eight genotypes NCGV 0107, NCGV 0504, NCGV 0704, NCGV 02096, NCGV 04096, NCGV 05096, NCGV 91176 and NCGV0204 have been selected for PYT in the next year.

Preliminary yield trial of groundnut (Set-I)

Eleven groundnut genotypes including 2 checks as Dhaka-1 and BARI Chinabadam-8 at were evaluated at Joydebpur, 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.

Significant differences were observed among the genotypes for all the characters studied at Joydebpur. Maturity duration ranged between 143-150 days. The genotype ICGV 00351 was most dwarf entry. Highest number of mature pods/plant was obtained by the entry ICGVS 36-1. The genotypes ICGVS 38-3, ICGVS 35-1 and ICGVS 36-1 were bold seeded. On average days to maturity ranged from 155-160 days. Average pod yield over the location ranged from 1627-2217 kg/ha. The entries ICGVS 36-1 produced maximum pod yield (2217 kg/ha) followed by ICGVS 38-3(2121 kg/ha) and ICGVS 35-1 (2016 kg/ha) which were 26%, 23% and 15% higher than the check variety Dhaka-1, respectively. Average performance was obtained from released variety BARI Chinabadam-8 (1989 kg/ha) which is 13% higher than the check variety Dhaka-1. As this was the first year result, the trial will be repeated next year.

Regional yield trial of groundnut (Set-1)

The experiment was conducted at Joydebpur, Jamalpur and Burirhat during rabi 2014-2015 with 16 promising genotypes of groundnut (collected from ICRISAT, India) including 3 checks Dhaka 1, BARI Chinabadam 8 and BINA Chinabadam 4. 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, 2014 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.

The average result of Joydebpur, Burirhat and Jamalpur locations showed that the days to maturity over three locations were similar with the check varieties. The released variety BARI Chinabadam 8 produced the maximum yield of 1911 kg/ha followed by BINA Chinabadam 4 (1809 kg/ha) and ICGV-00338 (1734 kg/ha) at Joydebpur. The variety BARI Chinabadam 8 also produce highest yield of 2001 kg/ha in Jamalpur while the entry ICGV-00338 (2350 kg/ha) in Burirhat. Three locations BARI Chinabadam 8 produced the maximum pod yield (1987 kg/ha).

Regional yield trial of groundnut (Set-II)

Eleven entries including two checks as Dhaka-1 and BARI Chinabadam 8 were evaluated at Joydebpur, Jamalpur, Ishurdi, Jessore, Rahmatpur and Hathazari. Seeds of different entries were sown on December 30, 2014 in a RCB design having 3 replications in Joydebpur. 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.

Mean performance over locations showed average days to maturity of five locations were almost similar to the check varieties. On an average the entry ICGV-95090 produced the maximum pod yield (1933 kg/ha) followed by ICGV-01080 (1767 kg/ha) which were 26% and 15% higher than the check variety Dhaka 1, respectively. The entries ICGV-96346 (1746 kg/ha) and ICGV-95090 (1694 kg/ha) also produced 14% and 10% higher yield than the check variety Dhaka-1. BARI Chinabadam 8 produced 17% higher yield than Dhaka-1.

Crop management

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 Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2014-15. BARIChinabadam-8 variety 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 17th November, 2014. 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). Soil measured by soil moisture meter (Model –TDR 200). 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. The genotypes were harvested at maturity. The current study shows appreciable differences among stages of growth in respect to their response to drought. It has also shown that the production of yield by groundnuts under water stress may be linked to maintenance of relatively low biomass under water stress. It may be concluded that where possible, adequate water must be available to groundnuts at all developmental stages in order to obtained an optimum yield. The results of the experiment revealed that flowering stage is the most susceptible growth stage to drought which would reduce seed yield and stover yield.

Effect of spacing on the growth and yield of high yielding varieties of groundnut

The experiment was conducted two locations during the period from November 2014 to May 2015 at the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and RARS, Jamalpur. The experiment was laid out in a Randomized Complete Block Design(factorial) with three replications. Three groundnut varieties were used viz. V_1: Dhaka-1, V_2: BARI Chinabadam-8 and V_3: BARI Chinabadam-9 and three spacing viz. S_1: 30 cm X 15cm, S_2: 35 cm X 15 cm and S_3: 40 cm X 15 cm were used in the study. The unit plot size was 4m X 3m. Fertilizers @ 30-32-43-54-2 kg/ha NPKSB were applied in the form of urea, triple super phosphate, muriate of potash, gypsum and boric acid respectively. Data were recorded on days to maturity, plant height, number of branches/plant, yield and yield components. Collected data were statistically analyzed and means were adjusted by LSD-test. Over all, for three different spacing conditions, BARI Chinabadam-8 and 9 performed better than Dhaka-1 where highest nut yield under S_2 spacing. Although yield contributing components give the lower values under S_2 spacing than S_3spacing but the yield is higher in S_2 spacing for all the varieties which might be attributed to higher number of plant population in S_2 (35cm X 15cm) spacing than S_3 (40cm X 15cm). From the above study, it was found that 35cm x 15 cm spacing produced higher nut yield for all the three groundnut varieties over the two locations. So, it may be concluded that the optimum spacing (35cm x 15 cm) would be better for BARI Chinabadam-8 and BARI Chinabadam-9.

Intercropping of chili with groundnut

The experiment was conducted during rabi season of 2014-15 at the research field of Oilseed Research Centre, BARI, Gazipur. There were six treatments namely; T_1: Sole groundnut (40cm x 15 cm), T_2: Sole Chili (30cm x 40 cm), T_3: 100% groundnut (40cm x 15 cm) + 1 row chili between two row of groundnut at 30cm plant to plant distance, T_4: 100% groundnut (40cm x 15 cm) + 1 row chili between two rows of groundnut at 40 cm plant to plant distance, T_5: 100% groundnut (40cm x 15 cm)+ 1 row chili between two rows of groundnut at 50cm plant to plant distance and T_6: 100% groundnut (40cm x 15 cm) + 1 row chili between two rows of groundnut at 60 cm plant to plant distance. The trial was laid out in Randomized Complete Block design with three replications. The unit plot size was 6m x 3.2 m. Groundnut was sown on November 17, 2014 and on the following day chili was transplanted according to treatments. Fertilizers were applied at the rate of 45-36-75-30-2-1-0.6 kg/ha NPKSZnBMo as Urea, Triple super phosphate (TSP), Muriate of Potash (MOP), Gypsum, Zinc Oxide, Boric Acid and Ammonium Molibdate for sole and intercrop. Half of N and full dose of other fertilizers were applied as basal. Rest of N were top dressed at flowering stage and covered with soil followed by irrigation. Chili was harvested 6 times by hand picking. Yield components of chili were taken from 5 randomly selected plants from each plot. Yields of both the crops were taken from whole plot. 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. Yield and yield components of chili were significantly affected by intercropping except no. of fruit /plant which is ranged from 280 to 320 in number. Maximum number of fruits was observed in T_6 treatment and minimum in T_3 treatment. The fruit length and diameter was highest in T_2treatment which was statistically similar with T_5 and T_6 treatment. The maximum yield reduction (%) of chili was found in T_6 treatment (47.28%) due to lowest number of chili plant and the minimum yield reduction (%) of chili was found in T_3 treatment (15.40%) due to highest number of chili plant. Nut number/plant, seed/nut and no. of branches/plant were not significantly affected by the intercropping system. 100 seed weight and shelling percent was highest in T_1 treatment i.e. 50.60 g and 72% respectively which were statistically identical with T_6 treatment (48.60 g and 70% respectively). The higher yield in T_1 treatment (2011 kg/ha) might be attributed to higher seed weight and shelling%. In the other hand, the lowest yield (1473 kg/ha) and maximum yield reduction (5) in T_3 might be due to lower seed weight and shelling % and higher competition for space and food. All the intercrop combinations produced higher groundnut equivalent yields (GEY) over both the sole crops. The highest GEY (3.42 t/ha) was observed in T_3 treatment followed by t_4 (3.28 t/ha) while the lowest (2.01 t/ha) in sole groundnut. Maximum gross return (Tk. 171000/ha) was recorded in T_3 treatment followed by T_4 treatment (Tk. 164000/ha) but these treatments did not give maximum benefit cost ratio (BCR) due to higher cultivation cost. However, the maximum BCR (4.53) was found in T_6 treatment. Results revealed that 1 row chili between two rows of groundnut at 60 cm plant spacing would be economically profitable for intercropping with 100% groundnut (40cm x 15 cm).

Performance of selected groundnut genotypes in char land area

The experiment was conducted two locations at the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and at farmer's field of Hossainpur, Kishoregonj . The experiment was laid out in a Randomized Complete Block design with three replications. Eight groundnut genotypes viz. ICGV-95399, ICGV-96175, ICGV-97232, J1987015-SL-1, ICGV-96390, ICGV-87860-G3, ICGV--1224-G-75 and ICGV-95070 were evaluated in this study. The unit plot size was 4m X 3m. Fertilizers @ 30-32-43-54-2 kg/ha NPKSB were applied in the form of urea, triple super phosphate, muriate of potash, gypsum and boric acid, respectively. All fertilizers were applied as basal. Intercultural operations like weeding, earthing up, pesticide application were done as and when required. Data were recorded on plant height, number branches/plant, yield and yield components. Collected data were statistically analyzed and means were adjusted by LSD-test. Among the eight genotypes seed yield was higher (2.35 T/ha)in ICGV-97232 which could be attributed to high shelling percent (73%) and pod/plant (22.3). From the above study it could be concluded that groundnut genotype ICGV-97232, ICGV-95070 and J1987015SL-1 performed better at Hossainpur, Kesoregonj. At Gazipur location, ICGV-97232, ICGV-95070 and ICGV-96390 performed better.

Pest management

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

An experiment was conducted at ORC, BARI, Joydebpur during rabi 2014-2015 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 seven lines (ICGV-00351, ICGV-18-1, ICGV-3479-G-37, ICGV-95098, ICGV-01105 and ICGV-01080 and ICGV-0104) showed resistant reaction against rust disease. Six lines showed resistant reaction against leaf spot. Three lines (ICGV-00351, ICGV-18-1, ICGV-3479-G-37 showed resistant reaction to both leaf spot and rust diseases. These lines may be included in breeding programme for development disease tolerance variety.

Management of foot rot of groundnut by organic amendments, fungicide and bio-control agent

An experiment was conducted during 2014-2015 cropping season to find out the suitable management practice in controlling foot rot disease of groundnut in the field at Oilseed Research Centre, BARI, Joydebpur. The experiment was designed in RCB with 3 replications where plot size was 3m x 2m. BARI Chinabadam-8 was used as planting material. The spacing was 40 cm x 10 cm. Nine treatments were included in this experiments. The treatments were: T_1= Seed treatment with Provax @ 2.5 g kg/seed, T_2= Soil application of Poultry refuse @ 5 t/ha at 21 days before sowing, T_3= Soil application of Mustard oil cake @ 1 t/ha at 21 days before sowing T_4= Soil application of Neem oil cake @ 500 kg/ha at 21 days before sowing T_5= Soil application of Poultry refuse + Provax (seed treatment), T_6= Soil application of Mustard oil cake + Provax (seed treatment), T_7= Soil application of Neem oil cake + Provax (seed treatment), T_8= Soil application of Trichoderma harzianum10g/m^2 at seed sowing , T_9 = Control . Foot rot incidence was recorded through regular monitoring and counting up to crop maturity. Recorded data were analyzed statistically using SAS 9.1.3 software. All the treatment gave significant reduction of foot rot of groundnut which ranged 36.22-57.44% .The highest and statistically similar disease reduction were obtained from soil application of poultry refuse + provax (T_5) and soil application of mustard oil cake + Provax (T_6). The highest yield (1681 kg/ha) was recorded from T_6 treatment which was statistically similar with T_5 (1609 kg/ha) treatment. From the study, it may be concluded that soil application of mustard oil cake or poultry refuse with seed treatment with Provax was effective option for reducing plant mortality and increasing seed yield of groundnut.

Sesame (*Sesamum indicum* L.)

Varietal Development

Preliminary yield trial of sesame

Twelve lines of sesame were evaluated at RARS Ishurdi, Jessore and Rahmatpur during kharif, 2015. The seeds were sown on 23th March at Ishurdi, 28th February at Jessore and 18th March at Rahmatpur, Barisal during kharif 2015. Two released varieties BARI Til 3 and BARITil-4 were used as check variety. The lines were laid out in a randomized complete block design with 3 replications. Unit plot size was 4 rows 4m long with the spacing of 40cm between rows and plant to plant continuous sowing. 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 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. Recorded data were analyzed statistically. Over three locations seed yield indicated that Ses-70 showed the highest yield performance at Ishurdi and Barisal followed by the genotype Ses-14. Among others entries, Ses-5 performed better than check BARI Til-4 at Ishurdi, Ses-Jp-25 and Ses-31 at Barisal. These entries were selected for RYT.

Regional yield trial of sesame (Set-I)

Ten entries of sesame including two check varieties as BARI Til-3 and BARI Til-4 were evaluated at RARS Ishurdi, Jessore, Rahmatpur and OFRD Khulna during kharif, 2015 for seed yield and other yield contributing character. The seeds were sown on 23th March at Ishurdi, 28th February at Jessore, 16th March at Rahmatpur and 24th February at OFRD Khulna during kharif 2015. The lines were laid out in a randomized complete block design with 3 replications. Unit plot size was 6 rows 4m long with the spacing of 40cm between rows and plant to plant continuous sowing. 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 flowering and maturity, and seed yield were taken on plot basis. The other yield contributing characters were recorded from 10 randomly selected plants of each plot. Recorded data were analyzed statistically. Considering seed yield, days to maturity and other yield contributing characters, the genotype Ses-9768 and Ses-05178 were selected for adaptive trial.

Regional yield trial of sesame (Set-II)

Ten lines of sesame having white or creamy seed coat color were evaluated at four locations during kharif, 2015. White seeded variety BINA Til-1 was used as check. BARI Til-4 having brown seed coat color also used as check as it is our latest variety. The seeds were sown on 23th March at Ishurdi, 28th February at Jessore, 17th March at Rahmatpur, Barisal and 25th February at Khulna during kharif 2015. The lines were laid out in a randomized complete block design with 3 replications. Unit plot size was 6 rows 4 m long with the spacing of 40cm between rows and plant to plant continuous sowing. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKSZn, respectively. Data on days to flowering and maturity, plant height (cm), no. of capsules/plant, no. of seeds/capsule and seed yield/plot (kg) were recorded. Data on days to flowering and maturity, and seed yield were taken on plot basis. The other yield contributing characters were recorded from 10 randomly selected plants of each plot. Recorded data were analyzed statistically. Over locations considering white seed coat color, seed yield and other yield contributing characters, Ses-JP-25 and Ses-JP-47 were selected for adaptive trial.

Pest management

Management of stem rot of sesame through fungicides

An experiment was conducted at Regional Agricultural Research Station, Jessore during Kharif -1 season of 2014-2015 to evaluate some fungicides in controlling stem rot disease of sesame. BARI

Til -3 was used as planting material. The experiment was designed in RCB with 3 replications .The unit plot size was 3m x 2m and seeds were sown on 20 April, 2015. Seven fungicides namely; Indofil (Mancozeb), Provax-200 (Carboxin + Thiram), Score (Haxaconazole), Tilt 250 EC (Propiconazole), Bavistin (Carbendazim), Contaf (Haxaconazole) and Dithane M-45 (Mancozeb) were sprayed three times. A control treatment was maintained for comparison. Three sprays were done at 10 days interval starting from appearance of the symptom of the disease. Irrigation and other cultural practices were done as and when necessary. Disease data were recorded following standard disease rating scale (Rahman and Rashid 2008) before 10 days of harvest. Post harvest data were recorded after necessary sun drying. Recorded data were analyzed statistically using SAS 9.1.3 software. Seven fungicides namely ; Indofil, Provax-200, Score, Tilt 250 EC, Bavistin, Contaf and Dithane M-45 were sprayed three times at 10 days interval. All the fungicides significantly reduced the percentage of plant mortality. Disease reduction over control ranged from 40.28-52.97%.The highest yield kg/ha was recorded from Score(1574 kg/ha) sprayed plot which was statistically similar with Contaf and Tilt 250 EC sprayed plot. The lowest yield was obtained from control plot. Score and Contaf were found effective fungicides for controlling the disease and increasing seed yield of sesame. This experiment will be repeated in the next year to draw any conclusion.

Evaluation of different management practices in controlling stem rot of sesame

The experiment was conducted to find out effective method in controlling stem rot of sesame at Oilseed Research Centre (ORC), Joydebpur during kharif season of 2014-2015 .Seeds of BARI Til-3 were sown on 06 March, 2015 and harvested on June 10, 2015.The experiment was designed in RCB with 3 replications where unit plot size was 3m x 2m. with 30cmx 10 cm spacing. Irrigation and other intercultural practices were done as and when necessary. Eight treatments were included in this experiments. The treatments namely T_1= Both seed treatment and foliar spray with Bavistin 50 WP (Carbendazim); T_2= Seed treatment and Spray with provax (Carbonix & Thiram) T_3= Seed treatment and Spray with Timsen(quaternary ammonium);T_4= Seed treatment with Onion bulb extract (1%w/v); T_5= Seed treatment with Onion bulb extract (1%w/v) and spray with Bavistin 50 Wp ; T_6 = Poultry refuse in the soil @ 6 t/ha before 20 days of planting was applied; T_7=Poultry refuse in the soil @ 6 t/ha before 20 days of planting was applied and Bavistin 50 WP spray and T_8=Control were maintained for comparison. The fungicides were sprayed three times at 10 days interval. Disease data were taken before fifteen days of crop harvest. From the result of the experiment it may be concluded that soil amendment with poultry refuse and spraying with Bavistin 50WP followed by both seed treatments and spraying were done with Bavistin gave lowest percent plant infection and also produced the highest yield and yield attribute of sesame. This was the second year trial. So, the experiment will be repeated in the next year for confirmation of the result.

Post Harvest and Bio-chemical Studies

Chemical characterization and nutritional evaluation of black and white sesame seeds in Bangladesh

Sesame is the most ancient crop cultivated for its oil in the sub-continent as well as Bangladesh. An analytical comparison of the biochemical composition of Black sesame (BS) and White sesame (WS) seeds produced in Bangladesh was carried out. The aim of the study was to analyze the BS and WS grown in Bangladesh and compare biochemical properties. Various approved methods that have been reported by researchers were used to do the analysis. Gas chromatography system was used to identify and quantify the fatty acids. Protein for WS and BS was 21.89% and 17.19%; fat/oil for WS and BS was 44.95% and 41.35%; moisture was higher in WS than BS and the amount was significantly different at $p<0.05$. The two colors of seeds were good sources of minerals. The fatty acids, oleic (39.88% for BS and 40.21% for WS) and linoleic (42.72% for BS and 43.87% for WS) acids, were the major unsaturated fatty acids which increases the suitability of sesame oil for human consumption.

Besides, palmitic (9.94% for BS and 9.79% for WS) and stearic (5.69% for BS and 4.79% for WS) acids, were the main saturated fatty acids observed in both samples. The overall results indicated that WS and BS have different biochemical properties.

Soybean (*Glycine max* L.)

Varietal Development

Maintenance and evaluation of soybean germplasm

A total of one hundred four 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 1 December 2014. Seeds were sown in two rows of 4m 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.

Considering the plant height, pods/plant and 100 seed weight 8 genotypes have been selected for growing in observation trial in the next year.

Observation trial of soybean

Eighteen entries including two check varieties namely BARI Soybean-5 and BARI Soybean-6 were evaluated in a RCB design with two replications for seed yield and it's components at Gazipur during rabi 2014-15. The unit plot size was 2 rows of 4 m long and the spacing was maintained 40cm between rows and 5 cm between plants. The sowing date was 18 December 2014. 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.

Four entries Givency, Santarose, PL-4171-75 and USDA 85 took minimum days to maturity (111-114 days) while four entries USDA-95, USDA-53, BARI Soybean-5 and BARI Soybean-6 took maximum days to mature (124-129 days). The most dwarf entries were USDA- 69 (17cm) and Santarose (18cm). The entries USDA 85, USDA 107 and Santarose produced the higher seed yield than the check variety.

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 to find out suitable soybean genotypes at Gazipur, Burirhat and Noakhali during rabi 2014-15. The unit plot size was 6 rows of 4 m long and the spacing was maintained 40cm × 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.

The genotype Givency showed maximum dwarfnees among the selected genotypes. The genotype GMOT-17 produced the highest number of pods while minimum was produced by the genotype Givency. Maximum hundred seed weight was recorded in Givency. Three entries as GMOT-17, KUSH-2004 and AGS-79 produced higher seed yield than both the check varieties.

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 Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2014-15. Thirty genotypes of soybean were evaluated against drought.Soil moisture measured by moisture meter (Model –TDR 200). 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, soil moisture were recorded 5 days interval. Seeds were sown on 14th December, 2014. After germination, plants were counted and excess plants were removed to maintain five plants in each pot. The genotypes were harvested at maturity. 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). Significant differences were observed among the genotypes for all characters except days to flowering and maturity. Number of mature pod/plant ranged from 20.0 - 46.75 and 7.00 -18.40 in normal and drought condition. The highest no. of mature pod (46.75 & 18.40) were found in USDA-46 and USDA-82 under control and drought situation condition and the highest no. of seed per pod (2.4) was found in genotypes USDA-82, USDA-66, USDA-41 and Slove -12 under normal situation and the highest no. of seed per pod (1.9) was found in genotypes USDA-90 in stress condition. The genotype USDA-79 and USDA-63 gave maximum 100 seed wt (14.27g) and (6.59) per plant under both situation (non stress and stress). The highest seed yield/plant (5.86 g and 3.40 g) was obtained from genotype BARI Soybean-6 and LG-92P1825 under both non stress and stress condition. The highest total dry matter per plant produced by BDsoybean-4 and BARI Soybean -6 (14.70 g & 6.45 g) under normal and stress condition. Water stress during seed development reduced seed yield via reduction of seed weight. Different drought indexing parameters like Dry matter stress index (DMSI), Yield stability (YS) and Stress tolerant index (STI) were calculated for thirty soybean genotypes. Under drought stress condition, DMSI and YS were >50% which indicate that genotypes were considered as tolerant to drought and STI was >0.8 which indicates that the genotypes gave higher yield in both conditions. The study indicate that performance of genotypes were different in terms of their susceptibility to drought. From the above results, it may be concluded that genotypes BARI Soy-5, BARI Soy-6, BR-33 and LG-92P1825 were selected on basis of stress tolerant index(STI>0.8) because they produced higher seed yield both in control and drought stress condition. The genotypes selected by STI might be cultivated under drought prone area. The experiment should be repeated for conformation of the result.

Pest management

Development of bio- control based management package against the major insect pest of Soybean

The experiment was conducted at the farmers field in Nokahali 2014-15. The highest infestation reduction of pest complex (common cutworm, leaf roller, pod borer and hairy caterpillar) was 87.36 in IPM Package-2 treated plots i.e. hand picking+ Sex pheromone of Sopdoptera litura + release of Bracon hebetor, Trychogramma chilonis and Tracer. The IPM package-2 produced the highest seed yield (2.01t/ha) with calculated the highest net return.

Evaluation of soybean entries against major insect pest

Eighteen (18) entries of soybean were evaluated against leaf roller, hairy caterpillar, pod borer, and common cut worm infestation during 2014-15 at ORC, BARI, Gazipur. Of these, four entries namely, USDA-8, Colombus, USDA-40,GMOT -13 were found comparatively less leaf roller (3.43-5.12%), hairy caterpillar (5.52-7.12%), common cutworm (3.11-8.48%) and pod borer(0) than the other entries and check variety BARI Soybean-6. The yield of these selected varieties were also higher than check and other entries.

Sunflower (*Hellianthus annus* L.)

Varietal Development

Maintenance and evaluation of sunflower germplasm

Sixteen genotypes of sunflower along with BARI Shurjomukhi-2 (check) were grown at the research field of ORC, BARI Gazipur on 19 November 2014. Seeds were sown in 2 rows x 3 m long plot, where row to row distance was 50 cm and plant to plant distance was 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.

The highest head diameter and highest seed weight/head and highest yield/plot were found in GP-04012. Minimum plant height was observed in BARI Sunflower-2 followed by GP-04018 and GP-04023. Highest CV% was recorded for the parameter number of seeds per head.

Development of dwarf inbred lines in sunflower advancing S_4 to S_5 generation

Two hundred and seventy six S_4 single plants of nine sunflower genotypes were grown at Gazipur. Seeds were sown on 19 November 2014 in ORC research field. Seeds were sown in 4 rows of 3 m long plot where the spacing was 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. 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). Some seeds of same plant height (75cm) and head size of BHAC-P-S-2 individuals (collected last year, 2013-14) which were bulked and sown in rabi 2014-15. These plants were covered with net to protect out crossing and isolation. Pollen of this genotype within a plot was collected and bulked. Then crossing was done within the heads of this genotype. These steps were taken to develop composite variety of sunflower.

A total of 276 heads of nine sunflower genotypes were selfed. The average plant height, head diameter, seeds/head and seed weight/head was presented in Table 2. The plants which have height close to 100 cm along with head diameter close to 20 cm had been selected to advance generation as S_5. One hundred and fifty five single plants were selected out of 276 selfed plants from 9 sunflower genotypes. These selfed single plants would be evaluated as S_5 and lines will be selected on the basis of their performance in the next year.

Observation yield trial of sunflower

Seven sunflower entries including one check BARI Surjomukhi-2 were evaluated for yield and yield contributing traits at Gazipur during the Rabi season of 2014-15. Experiments were laid out in RCB design with 2 replications. Unit plot size was 6 rows x 4 m long with spacing 50cm row to row and 25cm plant to plant. 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 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 taken on plot basis and was converted into yield/ha. Recorded data were analyzed statistically.

Significant differences were observed in case of plant height, head diameter, 1000 seed weight and yield. Significant difference was not found for days to mature and number of seed/head. The most dwarf entry was entry P-S-2(66cm) followed by entry no-10 (98.23). The highest number of seed/head was obtained from the check variety BARI Surjomukhi-2 followed by entry no-21. Highest thousand seed weight (90 g) was obtained from entry no -23 followed by entry-22 (84g) and entry - 20 (80g). Highest seed yield was found in the entry -21 followed by check variety BARI Sunflower-2 and entry -20. These two entries P-S-2 and entry- 21be selected for Preliminary Yield Trial.

Regional yield trial of sunflower

Nine sunflowers genotypes including one check BARI Surjomukhi-2 were evaluated for yield and yield contributing traits at Gazipur, Ishurdi, Jessore and Rahmatpur during the Rabi season of 2014-15 and seeds were sown at these locations on 18 November 14, 08 November14, 05 November 14 and on 24 November14 respectively. Experiments were laid out in RCB design with 3 replications. Unit plot size was 4 rows x 4 m long with spacing 50cm row to row and 25cm plant to plant. 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 taken on plot basis and was converted into yield/ha.Data on plant height and seed yield of the four regions were analyzed combinedly. Recorded data were analyzed statistically using SAS 9.1 software.

Significant differences among the genotypes were observed for maximum yield contributing characters except days to maturity and head diameter at Gazipur. The most dwarf genotype was SVS-00901 (126.4 cm) followed by BHAC-01030 (137.1cm). BHAC-04015 and BHAC-04026 produced more seeds/head than BARI Surjomukhi-2. Maximum thousand seed weight was obtained from BHAC-04026 followed by BHAC-04015 and BARI Surjomukhi-2. BHAC-04015, BHAC-04012 and BHAC-04017 gave higher seed yield than BARI Surjomukh-2. Among the genotypes SVS-00901was the most dwarf genotype at Gazipur.

Identification of parental lines for hybrid development in sunflower

Seeds of Hysun-33was collected from BRAC and sown during 2013-14 and developed S_1 generation. S_1 seeds were sown on 18 November 2014 during rabi 2014-15 in ORC research field. Seeds were sown 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 with pollen collected from the same flower using a soft brush would 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). Considering different characters 210 single plants were identified after selfed. Seeds of these plants would be grown as plant to row method to develop S_2 generation.

Crop management

Performance of sunflower varieties under different management practices

The experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2014-2015 to select suitable variety and management practice for higher yield of sunflower (BARI Sunflower 2 and SVS 00901). There were two varieties and three management combinations viz. M_1 = Poor 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 design as RCBD factoral (2 factor) with three replications. Seed were sown on 01 December 2014 at Benarpota with a row to row distance of 50 cm and plant to plant 25 cm. Unit plot size was 3m X 4m. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation as per treatment. The rest half of urea was applied as top dressing in accordance with the treatments. At every 7 days interval soil salinity (dS/m) was measured by EC meter (HANNA: HI 9835). Data on yield and yield contributing character were recorded and analyzed statistically using MSTAT-C program. Highest plant height (cm) was recorded in the interaction effect of V_1M_1 which is significantly higher than the rest of the interactions. Highest diameter of inflorescence was recorded in V_1M_2, V_1M_3, V_2M_2 and V_2M_3 set. Highest no. of seed/inflorescences was recorded in V_1M_3 which was statistically similar with V_1M_2 and V_2M_3 but significantly higher than the rest of the combinations. TSW (g) was found highest in V_1M_2 which was statistically similar with V_1M_3 and V_2M_3 combinations but significantly higher than the rest of the combinations. Highest seed yield (t/ha) was recorded in V_2M_3 combination which was significantly higher than the rest of the combinations. Stover yield (t/ha) also showed more or less similar trend. Lowest days to maturity were recorded in V_1M_1 which was statistically similar with V_2M_1 but significantly lower than the other variety and management combinations. BCR level (1.6) was highest for V_2M_3 than the other systems. The genotype/line (SVS 00901) under M_3 (Two irrigation come weeding at 30 and 60 DAE + 86: 24: 40: 30: 3:1: 0.8 kg/ha of NPKSMgZnB) management is suitable for higher yield and profit (BCR:1.66) of sunflower in the coastal area of Satkhira. This combination can reduce soil salinity up to 18.09%. For final recommendation experiment should be repeated for at least next 2-3 years.

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, Joydebpur during 2014-2015 cropping season. Seeds of BARI Sunflower-2 were sown on 20 November 2014 .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 = Dithen 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 $T_{7=}$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 these leaves or seeds with water at the ratio of 1:3(w/v). The crop was allowed to grow under natural infection. There sprays were applied on January 08, 18 and 01 February, 2015. In each plot 10 plants were randomly selected and tagged for data recording. 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. The PDI value of leaf spot was transform in arcsine transformation. Recorded data were analyzed statistically by using SAS 9.1.3 software .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.

Rovral and Indofil are best fungicides in controlling disease and increasing yield of sunflower over control. Allium Sativum bulb extract Followed by Mahogini Seed extract (MSE) perform better than other botanicals in respect of reducing the disease incidence and increasing the yield.

Linseed

Varietal Development

Maintenance of linseed germplasm

The experiment was carried at research field of ORC, Joydebpur during rabi 2014-15 with twenty genotypes of Linseed including the released variety Neela. Seeds were sown on November 25, 2014. The unit plot size of each genotype/line was 4m long with 4 rows maintaining 40cm and 10cm 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 rejuvenates in the next year.

Niger

Varietal Development

Maintenance of niger germplasm

The experiment was carried at research field of ORC, Joydebpur during rabi 2014-15 with twenty genotypes of Niger including the released variety Shova. Seeds were sown on November 25, 2014. The unit plot size of each genotype/line was 4m long with 4 rows maintaining 40cm and 10cm 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 rejuvenates the next year.

Safflower

Varietal Development
Maintenance of safflower germplasm

The trial was carried out at Joydebpur during rabi 2014-15 with 3 variable genotypes of safflower including the check line namely Saff-1. Seeds were sown on November 25, 2014. Each genotype/line was grown in a 4m long with 4 rows maintaining 40cm and 10cm 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 rejuvenates the next year.

Post harvest and biochemical studies

Comparative study of Rice bran oil and other edible oils in Bangladesh

Rice bran oil is less expensive non-conventional oil which has been found to improve the stability and its nutrient composition. The aim of the study was to analyze and compare the biochemical/ fatty acids profile of the Rice bran oil (RBO) and other edible oils in Bangladesh. Gas chromatography system was used to identify and quantify the fatty acids. The major fatty acids were found in RBO viz, 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 brand of RBO are 0.14-0.22%. Oryzanol have cholesterol-lowering properties and its beneficial effects viz, gastrointestinal disorders and nerve imbalance. The results indicated that RBO might be better oil compare with other edible oils.

5 SPICES CROPS

Onion

Varietal Development

Production of S_4 seeds for thin necked with longer shelf life on onion

The experiment was conducted at farmer's field under the supervision of Spices Research Centre, Shibganj, Bogra during 2014-2015 with a view to develop winter onion lines/varieties with short and thin necked bulb, longer shelf life and good yield potential from S_4 generation. Selected two types bulbs of S_4 generation viz., S_4-3 and S_4-7 were used in this study. Bulbs were planted for seed productions at farmer's field maintaining 1000 m isolation distance. It was observed that the highest plant height (90.0 cm) was found from S_4-3 generation followed by S_4-7 generation (88.0 cm). The S_4-3 generation showed the highest number of effective stalk per plant (4.8) followed by S_4-7 generation (4.6). The S_4-3 generation showed better performance in terms of 1000 seed weight (3.2 g) seed yield (796 Kg/ha) and germination percentage (87).

Development of open pollinated population on onion (Set-I)

The experiment was conducted at Regional Agriculture Research Station (RARS) Ishwardi, Pabna during 2014-2015 with a view to develop open pollinated population with good keeping quality. The materials were BARI Piaz-1, BARI Piaz-4 and mixed bulb of S_4 generation. At maturity seeds were harvested, processed and stored for further study in the following year. The amount of harvested seeds was 4 kg.

Development of open pollinated population on onion (Set-II)

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2014-2015 with a view to develop open pollinated population. The planting materials under study were BARI Piaz-1, 2, 3, 4, 5, ON0329, ON0330 and mixed bulbs of F_4 generation. At maturity seeds were harvested, processed and stored for further study in the following year. The amount of harvested seeds was 2 Kg.

Evaluation and selection of poly-crossed onion

The experiment was conducted at Regional Spices Research Center, BARI during November, 2014 to April 2015 to evaluate the variability created in onion germplasm through poly-crossing method. Eight poly-cross onion genotypes were evaluated considering agronomic performances and yield parameters. A lot of variations observed in respect to bulb size, attractiveness, color and shape of bulb compared to their mother bulb.

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

The experiment was conducted at Spices Research Sub-Centre, BARI, Faridpur during rabi season, 2014-15 to develop onion breeding line(s). Two different variety of onion viz. BARI Piaz-1 and BARI Piaz-4 were used for this study. 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 isolated bulbs of desired sizes and shapes (round/ flat/ glove/ broad elliptical/ spindle) were planted and selfed as well as OP seeds were produced. The maximum selfed seeds were obtained from BARI Piaz -4 spindle shape (42 g) and minimum selfed seeds were obtained from BARI Piaz -1 round shape (9 g). Between the variety, the highest open pollinated seeds were obtained from BARI Piaz -4 globe shape (222 g) and the lowest OP seeds were obtained from BARI Piaz -1 round shape (68 g). The collected seeds were harvested and stored separately. The seeds will be used for third generation bulb production in the next year.

Male sterility study in onion

The experiment was conducted at Spices Research Centre, Bogra during 2014 -2015 to find out the male sterile line for hybrid variety development of onion with desired traits. The planting materials were three onion germplasm (ON0329, ON0330 and ON0331), bulbil and bulbs of naturally male sterility showing plant. It was observed that naturally male sterility showing plant showed the highest (70%) male sterility followed by bulbil (30%), ON0331 (17%),ON0330 (15%) and ON0329 (10%).

Development of onion thrips tolerant line

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2014-2015 with a view to develop winter onion lines/varieties with tolerant to thrips and good yield potential. The S_2 seeds of ON0332 (glossy type, non waxy) were used in this study. It was observed that the minimum thrips population (7.68) was recorded in studied line (ON0332). Yield contributing characters were also studied and found satisfactory. The plant height (50 cm), leaf number (8.0), bulb diameter (4.5 cm) and bulb yield (10.80 t/ha) were recorded. At maturity stage bulbs were harvested, processed and stored for shelf life study especially for weight loss, rotten and sprouting behavior in the following year.

Cultural Management

Validation of onion seed production technologies at Faridpur region

The experiment was conducted during 2013-14 to 2014-15 at Faridpur region. In 2013-14, the trail was initiated at Spices Research Sub-Centre, Faridpur and at the farmer’s field while in 2014-15 the trail was conducted only at farmer’s field. In 2013-14, three seed production practices viz. i) SRC recommended practice, ii) Farmers practice and iii) Farmers practice + 1 irrigation more (given at 50 DAP) were studied. However, in 2014-15, another treatment Farmers practice + SRC spacing was included to the above treatments. In 2013-14, the highest seed yield (684.5 kg/ha at SRSC, Faridpur and 807.6 kg/ha at farmers field) was obtained from SRC recommended practice, which differed significantly from other treatments. In 2014-15, the highest seed yield (536.5 kg/ha) was obtained from SRC practice which was identical to farmers practice + SRC recommended spacing (504.5 kg/ha).

Effect of herbicides and time of spraying for weed control in onion seed production

The experiment was conducted at Spices Research Centre, Shibgonj, Bogra during rabi season, 2013-14 and 2014-15 to select the suitable herbicide(s) and optimum time of spraying for better weed control for maximizing higher seed yield of onion. 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. Twelve weed control treatments viz.,01 HW at 15 DAE, 01 HW at 15 DAE + Panida (Pendimethalin), 01 HW at 15 DAE + Weeder (oxadizon),02 HW at 15 & 30 DAE, 02 HW at 15 & 30 DAE + Panida, 02 HW at 15 & 30 DAE + Weeder, 03 HW at 15, 30& 45 DAE, 03 HW at 15, 30 & 45 DAE+ Panida, 03 HW at 15, 30& 45 DAE + Weeder, 4 HW weeding at 15, 30, 45 & 60 DAE,4 HW weeding at 15, 30, 45 &60 DAE + panida and 4 HW weeding at 15, 30, 45 & 60 DAE + weeder and Control (No weeding + No spraying) were compared. In both the years, the highest seed yield (505.7 kg/ha in 2013-14 & 487.6 kg/ha in 2014-15) was obtained from 4 HW at 15, 30, 45 and 60 DAE +

Panida which was identical to 4HW, 4HW + weeder, 3HW, 3HW + panida, 3HW + weeder, 2HW + Panida and 2HW + weeder. The seed yield of these treatments was higher due to lesser weed competition. The result indicated that application of herbicides along with 2 or 3 or 4 hand weeding effectively controlled broad leaf weeds. The lowest seed yield was recorded from un-weeded control (118.0 kg/ha in 2013-14 & 132.8 kg/ha in 2014-15). The major weed species were *Cyperus rotundus, Physalis heterophylla, Cynodon dactylon, Amaranthus spinosus and Rumex dentatus.*

Effect of planting method on onion bulb production

The experiment was conducted during rabi season 2014-15 at Spices Research Sub-Centre, Faridpur. The experiment was conducted in randomized complete block design with six replications with 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. In 1) SRC recommended practice: seed sowing (2nd week of November) + seedlings transplanting (At the end of December) + Spacing (10cm x 10cm) + Irrigation (4 times) + weeding (four at 15, 25, 45 and 60 DAT) + Fungicide (Rovral and score, four spray when disease appears) + Insecticide (2-3 spray when thrips/ insect appears) + Fertilizer doses (cow dung 5 ton, N_{120}, P_{54}, k_{75} and S_{20} kg per hectare and at 2) Farmer's practice: Seed sowing (Last week of November) at flat seed bed + seedling transplanting (3rd week of January) at flat method + Spacing (10cm x 7cm) + Irrigation (2-3 times) + Weeding (2times) + Fungicide (Rovral and Score applied at 7 days interval + insecticide (were considered applied when thrips/ insect appears) + Fertilizer doses (N_{46}, P_{45}, k_{30} and S_{16} kg per hectare). The results of the study revealed that planting method and management practices had significant impact on yield and yield attributes of onion. Significantly highest yield (14.42 t/ha) was recorded from raised bed + SRC recommended practice and the lowest yield (8.055 t/ha) was recorded from Flat method + Farmer's practice.

Insect pest and disease management

Screening of onion germplasm against thrips (*Thrips tabaci*)

A field experiment was conducted at SRC, Bogra during rabi 2014-2015 to test the performance of some onion germplasm against thrips. The highest number of thrips population was recorded from ONO 281-1 (13.35 thrips/ plant) and the lowest number of thrips population was recorded from ONO 282 (3.98 thrips/ plant). Among the varieties the highest bulb yield was obtained from BARI Piaz-4 (15.92 t/ha). ONO 282 and ONO 278 showed minimum thrips infestation with identical bulb yield. This indicates the superiority of these lines among other lines and variety.

Integrated management of onion thrips (*Thrips tabaci*)

Several management approaches were evaluated against thrips in onion at SRC, Bogra during rabi 2014-2015. BARI Piaz-4 was the test crop. The reduction of thrips population was maximum (88.42%) from installation of sticky white trap + Spinosad (Tracer 45SC @0.4ml/ L of water) followed by installation of Sticky white trap + chlorfenapyr (intrapid 10SC @ 1ml/ L of water) treated plot (86.15%). These two treatments were statistically similar. The highest yield (21.35t/ha) was also obtained from installation of sticky white trap + Spinosad (Tracer 45SC @0.4ml/ L of water) treated plot and the highest MBCR (13.95) was also obtained from the same treatment.

Management of thrips in seed onions to enhanced seed yield

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to evaluate the efficacy of bio-rational and synthetic insecticides against thrips infestation to enhance seed yield of onion. The treatments were T_1= White sticky trap @ 40 trap/ha; T_2= Biopesticide-Bioneem plus (Azadiractin 1EC) @ 1ml/litre of water; T_3= Biopesticide-Bioneem plus (Azadiractin 1EC) @ 1ml/litre of water + White sticky trap @ 40 trap/ha; T_4= Thiamethoxam (Actara 25WG) @ 0.2g/litre of water + White sticky trap@ 40 trap/ha; T_5= Alternate spraying of Biopesticide- Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water and Bioneem plus (Azadiractin 1EC) @ 1ml/litre of water and T_6= Untreated control. Alternate spraying of Biopesticide- Spinosad (Success 2.5 SC) @ 1.2ml/litre of water and Bioneem plus (Azadiractin 1EC) @ 1ml/litre of water offered the lowest thrips population (2.15 thrips/ plant and 2.88 thrips /umbel). The highest percentage of thrips population (84.99% in plant and 71.63% in umbel) reduction over control was also obtained from alternate spraying of Biopesticide- Spinosad and Bioneem plus (Azadiractin 1EC) treated plot followed by Bioneem plus (Azadiractin 1EC) + White sticky trap treated plot (72.70% and 55.86%). The highest onion seed yield (395.3 kg/ha) and marginal benefit cost ratio (19.43) was also obtained from alternate spraying of Biopesticide- Spinosad and Bioneem plus (Azadiractin 1EC) treated plot. So, alternate spraying of Biopesticide-Spinosad and Bioneem plus (Azadiractin 1EC) may be recommended for effective management of thrips in onion seed production.

Development of insecticide based management approach against thrips and iris yellow spot virus in onion

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to evaluate the efficacy of different insecticides for the management of thrips and Iris yellow spot virus on onion bulb crop. Six treatments (Five insecticides + control) were replicated three times in randomized complete block design. The treatments were T_1= Spraying of Spirotetramat (Movento 150SC) @ 1ml/litre of water; T_2= Spraying of Thiamethoxam (Actara 25WG) @ 0.2g/litre of water; T_3= Spraying of Imidaclorprid (Confidor 70WG) @ 0.2g/ litre of water; T_4= Spraying of Chlorphenapyr (Intrepid 10SC) @ 1ml/litre of water ; T_5= Spraying of Bio-pesticide Spinosad (Success 2.5SC) @ 1.2ml/litre of water and T_6= Untreated control. All the insecticides were significantly better than untreated check in reducing pest population after both applications. Success proved best followed by Intrepid and Confidor. Thrips populations are positively correlated with Iris yellow spot virus in onion. Maximum marginal benefit-cost ratio was recorded for Success 2.5SC (31.99) followed by Intrepid 10SC (28.76) and the least was recorded for Actara 25WG (12.88) treated plots. This study showed that Success 2.5SC and Intrepid 10SC may be recommended for the management of thrips and Iris yellow spot virus in onion.

Effect of different transplanting dates for the management of thrips in onion

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to assess the effect of varying transplanting dates on thrips populations and onion bulb yield. The treatments were T_1= 20 November (1^{st} transplanting); T_2=05 December (2^{nd} transplanting); T_3=20 December (3^{rd} transplanting); T_4= 05 January (4^{th} transplanting) and T_5= 20 January (5^{th} transplanting). Transplanting was done at 15 days interval from November to January. Results showed that early transplanting in 20 November and 5 December had fewer thrips (6.72 thrips/plant and 9.81 thrips/plant) than the subsequent ones. November transplanting was free of thrips up to 9 weeks after transplanting (WAT), December transplanting up to 8 WAT and January transplanting up to 4 WAT. Onion bulb yields were also found to differ in descending order as follows: 20 November (22.90 t/ha)> 05 December (19.95 t/ha)> 20 December (19.60 t/ha)> 05 January (8.25 t/ha)> 20 January (6.32 t/ha).

Population dynamics and management of thrips in bulb onion by use of vegetable intercrops

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to study the population dynamics and to evaluate the effectiveness of intercropping carrot, tomato and french bean with onion for the management of thrips in onion. BARI Piaz-1 was intercropped with each of the vegetables and insecticide imidacloprid was used as a standard check .The treatments were T_1= Onion intercropped with carrot; T_2= Onion intercropped with tomato; T_3= Onion intercropped with french bean; T_4= Imidacloprid (Admire 200SL) @ 0.5ml/ L (as standard check) and T_5= Untreated control. Infestation of onion thrips was started from the first week of February than it become gradually increases to the first week of April after that it was decline. Thrips population were positively correlated with temperature and negatively correlated with relative humidity and rainfall. Thrips damage incidence and severity were determined every 7 days with damage severity being estimated on a scale of 1-5. Total and marketable bulb yield were determined at physiological maturity. Intercropping onion with carrot, tomato and insecticide Imidacloprid significantly reduced thrips population up to 52.42%, 48.84% and 58.97%, respectively, but french bean had no significant effect. The three vegetable intercrops significantly reduced thrips damage severity, with insecticide imidacloprid having the greatest reduction up to 23.81% followed by carrot up to 21.04% and tomato up to11.90%. Intercropping onion with carrot and tomato significantly reduced onion bulb yield while the effect of french bean and imidacloprid on yield was not significant. The reduction in bulb yield was compensated by the yield from the vegetable intercrops and, therefore, no net loss was incurred to these treatments. This study showed that carrot or tomato intercrop may be utilized in the management of onion thrips.

Screening of onion lines/varieties against Stemphylium leaf blight disease

A field experiment was conducted at Spices Research Centre, Shibgonj, Bogra during 2014-2015 to find out resistant/ tolerant onion lines/varieties against stemphylium leaf blight disease. Sixteen line/ varieties of onion were used in this experiment. All the onions line/ varieties showed moderately susceptible reaction against stemphylium leaf blight disease.

Efficacy of new fungicides in controlling stemphylium leaf blight of onion

A field experiment was conducted at Spices Research Centre, Shibgonj, Bogra during 2014-2015 to find out the effectiveness of 16 (sixteen) new fungicides against stemphylium leaf blight of onion. Among the treatments higher disease reduction was recorded by well rounder 75 WG, Strom 75WG, Nobin, Amister Top and Sunchonce 75 WG.

Efficacy of fungicides in controlling purple blotch of onion

A field experiment was conducted at the research field of Regional Spices Research Centre, BARI, Gazipur using seedling of BARI Piaz-1 during 2014-2015 cropping season to evaluate the efficacy of some fungicides in controlling purple blotch of onion. Seven treatments (Six fungicides including known check Rovral and one control) were arranged in Randomized Complete Block Design with three replications. Among the fungicidal treatments Topral-50wp (Iprodione) @ 2g/l showed the best performance in reducing the purple blotch as well as increase the seed yield.

Garlic

Varietal Development

RYT of promising garlic line

The experiment was conducted at Spices Research Center, Bogra; Spices Research Sub-Center Lalmonirhat; Bangladesh Agricultural Research Station, Thakurgaon; Regional Spices Research Center, Magura and Spics Research Sub-Center, Faridpur during November 2014 to March 2015.Four garlic advance lines (GC0018, GC0024, GC0017 and GC0034) and BARI Rashun-1 as check were included in the study. In case of location the highest yield (8.69 t/ha) was recorded in SRC, Bogra and the lowest yield was recorded on (6.63 t/ha) in Faridpur location. In case of variety the highest yield (8.70 t/ha) was found from GC0034 while the lowest (5.84 t/ha) was found from BARI Rashun-1. The combined effect of location × advance line gave significant effect on yield and other parameter. The highest yield (11.11 t/ha) was obtained from GC0034 with SRC, Bogra location, while the lowest yield (5.40 t/ha) from BARI Rashun-1 with Lalmonirhat 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 location. Considering all the characters, the lines (GC0018, GC0024 and GC0034) were found promising and selected for next year trial.

On-farm verification trial of garlic varieties

The experiment was conducted at Spices Research Center, Bogra, at farmers field under Agricultural Research Station Thakurgaon; On farm research division, Patuakhali; Banderban and Sylhet during rabi season 2014-15. Two garlic variety (BARI Rashun-1, BARI Rashun-2 and local cultivar as checks were included in the study. Among the variety under study it was observed that the BARI modern garlic variety BARI Rashun-2, was superior to BARI Rashun-1 and local cultivar in each location. In case of location, the highest yield (8.75 t/ha) was recorded at SRC, Bogra. The lowest yield was recorded (3.4 t/ha) at Sylhet. In case of variety the highest yield (8.71 t/ha) was found from BARI Rashun-2 while the lowest was found from local cultivator. Combined (5.02 t/ha) effect of location x variety gave significant effect on yield and other parameter. The highest yield (10.80 t/ha) was obtained from BARI Rashun-2 with SRC, Bogra location, while the lowest yield (2.69 t/ha) was obtained from local cultivar with Sylhet location BARI. Rashun-2 showed better performance in all locations.

Study of the genetic diversity of garlic

D^2 analysis of 14 garlic lines and analysis of variance were done. The lines were grouped into four clusters. The-inter cluster distance was larger than the intra-cluster distances suggesting a wider genetic diversity among the germplasm of the different group. The highest inter cluster distance was found between cluster I and IV (16.243) followed by cluster II and IV (12.967) and III and V (8.589). The line in cluster IV (GC0013, GC0027, GC0035, GC0036, GC0038, GC0040) and the germplasm in cluster I (GC001) grouped here could be used for future breeding work.

Evaluation of garlic germplasm

The trial was conducted at Regional Spices Research Centre, BARI, Gazipur, during rabi Season 2014-2015. Nine different garlic line/ varieties (ASGAZ001, ASGAZ002, ASGAZ003, ASGAZ004, ASGAZ005, ASGAZ006, BARI Rashun-1, BARI Rashun-2, and ASGAZ009) were evaluated based on their yield and other desirable characters. Most of the lines gave good yield having medium to good growth condition. Among the lines, the larger cloves (19.87 g) and highest yield (9.87 t/ha) was obtained from BARI Rashun-1 and the lowest clove (10.87 g) and yield (5.62 t/ha) was obtained from ASGAZ002. There were few variations among the germplasm in previous year but no one was outstanding compared to release varieties.

Screening of garlic lines against premature sprouting

The experiment was conducted at Spices Research Sub-Centre, Faridpur and OFRD, Pabna during rabi season, 2013-14 and at SRSC Faridpur during rabi season, 2014-15to select high yielding varieties with resistance or tolerance against premature sprouting. Ten different collected garlic lines (GC001, GC005, GC0012, GC0017, GC0018, GC0024, GC0027, GC0028, GC0031 and GC0036) and three local germplasm (GC0038, GC0039 and GC0040) along with BARI Rashun-1 and BARI Rashun-2 as check were evaluated. The experiment was laid out in RCB design with three replications. All yield contributing characters showed significant difference, except population per m^2 and bulb diameter. In 2013-14, the highest percent of premature sprouting was observed with GC0038 (14.49%)in Faridpur (L_1) and GC0039 (41.33%) in Pabna (L_2). The lowest percentage of Premature sprouting was observed with GC0024 (0.98 %) in Faridpur (L_1) and with GC0031 (0.473 %) in Pabna (L_2). Both in Faridpur (7.01 t/ha) and Pabna (11.07 t/ha) highest bulb yield was achieved from BARI Rashun-1 and the lowest yield (4.43 t/ha) was recorded from GC005 at Faridpur. In 2014-15, the highest percentage of premature sprouting was found from GC0040 (6.72 %) and the lowest percentage of premature sprouting was observed from GC0038 (1.167%) and GC0039 (1.167%). The highest bulb yield was recorded from BARI Rashun-2 (8.867 t/ha) and the lowest yield (4.810 t/ha) was recorded from GC0036.

Cultural Management

Effects of clove weight and plant density on vegetative growth development and yield of garlic

A field trail was carried out during growing season 2014-15 at the Spices Research Sub-Centre, BARI, Lalmonirhat to study the effect of clove weight and spacing on vegetative growth, development and yield of garlic. Three clove weights viz. small (1.0 ± 0.2)g, medium(1.5 ± 0.2)g and large(2.0 ± 0.2)g and three plant spacing viz. 15cm × 10cm, 10cm × 10cm and 10cm × 7.5cm were used as treatment having a randomized complete block design with four replications. The vegetative growth, yield component and yield parameters were significantly higher with large clove weight and small spacing. The combination of large clove weight with small spacing (10cm × 7.5cm) produced the highest garlic yield (8.16 t/ha) while the highest bulb weight (23.43g) was obtained from large clove weight with wider spacing (10cm × 10cm) compared with the combination of small clove weight and wide spacing (15cm × 10cm). However, number of leaves /plant exhibited non-significant variation by spacing and interaction effect. The percentage of increase in bulb yield at harvest was 48.09% in respect of large clove weight with small spacing (10cm × 7.5cm) compared to small clove weight with wider spacing (15cm × 10cm).

Performance of different garlic varieties under mulch condition

The demonstration was conducted at MLT site Atghoria, Pabna during the rabi season of 2014-15 to evaluate the performance of garlic varieties (BARI Rashun-1, BARI Rashun-2 and local) under zero tillage mulching. BARI Rashun-2 produced higher yield over local variety and BARI Rashun-1. Gross margin (381994 Tk. ha^{-1}) was also higher in BARI Rashun-2. BARI Rashun-1 showed poor performance regarding yield and economic return.

Insect pest and disease management

Evaluation of garlic genotypes against thrips

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to test the performance of garlic genotypes against thrips. Fifteen different garlic genotypes (GC001, GC005, GC0012, GC0013, GC0017, GC0018, GC0024, GC0027, GC0028, GC0029, GC0030, GC0031, GC0034, GC0035 and GC0036) along with BARI Rashun 1 and 2 were evaluated against thrips. Out of fifteen genotypes, GCO34 recording less than 8.29 thrips per plant and higher bulb yield (9.78 t/ha) was characterized as highly resistant. Genotypes GC0013, GC0028 and GC0030 recorded higher thrips population of more than 13.41 thrips per plant and lower bulb yield (4.07, 4.52 and 2.68 t/ha, respectively) were grouped into highly susceptible.

Identification of garlic leaf blight: first time record in Bangladesh

The field expt. Wast conducted at SRC, Bogra during Rabi season of 2014-15. Different species of Stemphylium causing leaf blights, resulting severe damage of garlic is one of the most important diseases of garlic in Hubei province, China. In Bangladesh, from the last few years, a new disease symptom on garlic plants were observed, showing blight symptoms killing the leaves progressively. In 2015, garlic plants in several commercial fields of Bogra, Natore, Rajshahi and Faridpur districts, and the field Spices Research Centre (SRC), Bogra exhibited symptoms of blight on the leaves. Early symptoms were observed as white spots (1-3 mm), which enlarged to produce sunken purple lesions, extending until the leaves withered. Healthy leaves contacted diseased tissues of neighboring plants, allowing for abundant mycelial growth with profuse conidial production on the newly infected tissues. The disease is widespread in Asia and Europe and in New York. It was first recorded on garlic in India. More recently it has been reported on garlic in the United States of America, South Africa, Spain, Brazil and Australia. This is the first report for Bangladesh. Earlier this leaf blight disease of garlic was not detected, so this is the first time recorded on garlic Bangladesh

Post harvest technology

Osmotic dehydration of garlic

The experiment was conducted at Spices Research Center, Shibgonj, Bogra to study the drying behavior of garlic by osmotic dehydration (OD) and /or combined OD and air drying and development of dehydrated garlic products. The rate of extent of weight loss , moisture content, solid gained and normalized solid content (NSC) were strongly influenced by strength of osmotic solution, immersion time and were rapid during the first 6 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 and NSC increased with increasing temperature. It is also found that the lower the thickness the higher is the %WL, %SG and NSC. Garlic slice/cloves were stored in alluminium foil packet and HDPE at refrigerated temperature as well as room temperature. Both products were acceptable in all the temperature up to 1 year's of storage.

Chilli

Varietal Development

Regional yield trial of summer chilli lines

Three chilli lines viz. C0517-4 (V_1), C0517-8(V_2), and C0590 (V_3) were evaluated with BARI Morich-1 as check at three locations viz., Regional Spices Research Centre, Joydebpur (L_1); Spices Research Centre, Bogra (L_2) and Spices Research Sub-Center, Lalmonirhat (L_3) during March to September, 2014, to study the regional adaptability of different chilli lines. The experiment was laid out in RCB design with four replications in each location. Chilli seedlings of 35-40 days old were transplanted on April 08-10, 2014 and the crop (Green chilli) was started to harvest from May-June and completed on August-September, 2014. The maximum number of fruits/plant (220.43) was harvested at Lalmonirhat with higher weight of fruits/plant (339 g) and fruit breadth (0.89 cm). The highest yield (t/ha) was obtained from Lalmonirhat (11.82) followed by Bogra location (10.94).All parameters showed significant differences due to different lines. The number of fruits/plant (242.96), weight of fruits/plant (428.60 g) and significantly the highest chilli yield (13.48 t/ha) was obtained from C0590 followed by C0517-8 (11.39). The line × location effect of fruit weight and yield exhibited highly significant variations. The results indicated that C0590 gave the highest yield with highest weight of fruits across the locations.

On farm trial of chilli variety

The experiment was conducted during February to October, 2014 to evaluate the performances of chilli variety at different agro-ecological zones and to popularize new chilli variety at different locations among the farmers to promote their adoption. The BARI Morich-2 and local chilli (respective area) were evaluated at four locations viz. L_1 = Rangpur, L_2 = Faridpur, L_3 = Jessore and L_4 = Satkhira. The experiment was laid out in RCB design with five replications in each location. Seedlings of 40-45 days old were transplanted on April 10-28, 2014. All parameters showed highly significant differences in chilli variety /line across all locations .The tallest plant was attained in Jessore (97.18cm) followed by Rangpur location (95.88 cm) though there was no significant variation. Heaviour fruits/ plant (367.07 g) and maximum weighed fruit (2.08g) and significantly the highest yield (8.48 t/ha) was obtained at Jessore location followed by Rangpur. The tested variety regarding different characters exhibited significant differences irrespective of locations BARI Morich-2 possessed highest plant (92.84 cm), maximum number (215.5) and weight of fruit (314.54g). The highest yield was obtained from BARI Morich -2(8.40t/ha) having longest sized (5.49 cm x 0.84 cm) fruit compared to local chilli line. The variety × location effect also showed highly significance differences in respect of different yield contributing attributes .BARI Morich -2 gave the highest yield (9.75 t/ha) with maximum number of fruits (364.40) at Jessore location followed by Rangpur and Faridpur locations.

Studies on genetic diversity in chilli

The analysis of variance for all the quantitative traits showed highly significant variations among the genotypes. Surjomukhi showed highest performance for yield/plant (g). Higher GCV and PCV were found in fruit weight (02.775 and 64.243, respectively) and yield per plant (53.721 and 56.989, respectively) indicating wide range of diversity for the characters studied. High heritability coupled with high genetic advance was observed for fruit weight, fruits/plant and yield/plant indicating additive gene action. Thirty genotypes were grouped into 6 clusters and among them cluster I was the largest with 13 genotypes followed by cluster II with 5 genotypes, cluster III and IV with 4 genotypes, cluster V with 3 genotypes whereas cluster VI was of solitary type. The inter cluster D^2 values ranged widely with a minimum value of 83.03279 between clusters II and IV and maximum value of 561.6824between clusters II and VI indicating high diversity among the genotypes of these clusters. The genotypes Surjomukhi for yield, Bindu morich, Golmorich and BARI Morich-2 for number of fruits/plant could be selected as suitable parental lines for further breeding programme to develop high yielding chilli varieties.

Development of year round chilli variety through pure line selection

The experiment was conducted during kharif season of 2013 and 2014 at Spices Research Sub-Centre, Faridpur to develop year round chilli variety with better qualities of green chilli. The experiment was carried out through the process of pure line selection. It was a non- replicated trial. A local germplasm of chilli C0583 was the material of this study. In 2013-14, the plant attained 85 cm in height. The fruits were elongated having 12 cm length and 1.5 cm width. The average weight of individual fruit was 2.8 g. It gave 650-700 red ripe fruits/plant and 1540 g fruit weight/plant up to 4 harvest. In 2014-15, the plant height was 78 cm, the fruits were elongated with 10 cm length and 1.4 cm width. Individual fruit weight was 2.6g.It gave 600-650 red ripe fruit and 1380 g fruit weight/plant up to 4 harvests.

Evaluation of naga chilli lines

The experiment was conducted at CRS, Jaintiapur during rabi season from December 2014 to May 2015 for selecting superior line(s) as variety. Two Naga chilli lines CC Jai-010 and CC Jai-018 were selected from previous year’s study and were tested as the experimental material. The experiment was conducted in randomized complete block design with twelve replications. The experimental plot was located under AEZ 22 with sandy loam soil having extremely acidic (4.5-4.8) pH. All the growth parameters showed significant variation among the lines tested. Growth conditions of the lines were satisfactory. Maximum fruit size and weight was obtained from CC Jai-010 while the minimum was from CC Jai-018. This line was not infected by mites. Considering all the parameters CC Jai-010 may be further investigated for advanced yield trial.

Cultural Management

Inter-cropping turmeric with chilli for higher productivity

The experiment was conducted at Spices Research Centre, Shibgonj, Bogra during 2013-14 & 2014-15 to find out better crop combination(s) of turmeric with chilli inter cropping system and to increase the total productivity of the system. Six intercrop combinations viz., one row of turmeric followed by one row of chilli, two rows of turmeric followed by one row of chilli, two rows of turmeric followed by two rows of chilli, three rows of turmeric followed by one row of chilli, three rows of turmeric followed by two rows of chilli and farmers' practice along with sole turmeric and sole chilli were compared. Different intercrop combinations significantly affected both rhizome and chilli yield. In both the years, the highest rhizome yield of turmeric was recorded from sole turmeric (45.41 t/ha in 2013-14 & 37.55 t/ha in 2014-15) and the highest chilli yield was recorded from sole chilli (13.55 t/ha in 2013-14 & 11.21 t/ha in 2014-15). The highest turmeric equivalent yield (58.55 t/ha in 2013-14 & 53.23 t/ha in 2014-15) was recorded from 1 row of turmeric followed by 1 row of chilli which was closely followed by 2 rows of turmeric followed by 1 row of chilli (57.94 t/ha in 2013-14 and 51.73 t/ha in 2014-15). Similarly, the highest gross return and net return was recorded from 1 row of turmeric followed by 1 row of chilli, which was closely followed by 2 rows of turmeric followed by 1 row of chilli. The LER was higher with one row of turmeric followed by one row of chilli. However, in both the years, the benefit-cost ratio (6.51 in 2013-14 & 5.74 in 2014-15) was highest with 2 rows of turmeric followed by 1 row of chilli, which was closely followed by 1 row of turmeric followed by 1 row of chilli (6.39 in 2013-14 & 5.72 in 2014-15).

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 September, 2015 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 harvest ripening period viz., 0 (PHR_1), 3 (PHR_2) ,6 (PHR_3) and 9 (PHR_4) days after harvesting (DAH) with three replications in two factors RCB design. Seedlings of 35-40 day ages were planted on April, 2014 maintaining 60cm × 25cm spacing in 4.0 m × 2. 4 m sized unit plot .Seeds from the fruits were extracted manually and placed on blotting papers in Petridis. The observations on days to 1st germination, germination percentage, root and shoot length (cm), vigour index and germination index were recorded as per ISTA procedures (Anonymous, 1996). Seeds obtained immediately after harvested fruits (0 day) gave maximum germination percentage (99.04) at red ripe stage. Fruits harvested at red ripe stage with 0(zero) and 3 days of post harvest ripening period recorded longest shoot (3.11 cm and 3.06 cm, respectively) and maximum vigour index (821.90 and 722.57), respectively. Maximum germination index was recorded when the fruits were harvested at wrinkle stage and allowed to 0 (zero), 3, 6 and 9 days of post harvest ripening period.

Nutrient Management

Effect of NPKS on growth and yield of naga chili

The experiment was conducted at Spices Research Sub-Station, CRS, Jaintiapur in Rabi season of 2014-15 for selecting proper dose of NPKS for naga chilli Production. There were 14 treatment combinations comprising four levels each of N (0, 80, 100 and 120 kg/ha), P (0, 50, 75 and 100 kg/ha), K (0, 100, 120 and 140 kg/ha) and S (0, 10, 20 and 30 kg/ha). The experiment was laid out in Randomized Complete Block Design with three replications. There were significant variations among the treatments with plant height (cm), canopy spreading (cm), stem diameter (cm), Number of fruits per plant, fruit weight (g), fruit length and diameter (cm), pericarp weight (g), number of seeds per fruit, 1000 Seed weight (g), and fruit yield (t/ha) of naga chilli. The taller plant, highest stem diameter and canopy spreading of naga chilli plants were achieved from the treatment N_{100} P_{75} K_{120} S_{20} (T_3) while the control (native nutrient) exhibited the lowest. The maximum yield were obtained from N_{100} P_{50} K_{120} S_{20} (25.77 t/ha) followed by N_{100} P_{50} K_{120} S_{20} (24.83 t/ha) and N_{80} P_{75} K_{120} S_{20} kg/ha (24.40 t/ha) where as the control plots yielded the minimum (8.75 t/ha). Application of N_{100} P_{75} K_{120} S_{20} kg/ha (T_3) appear to be the best treatment for maximizing the growth and yield of naga chilli for Sylhet region.

Insect pest and disease management

Development of eco-friendly pest management practices against thrips-mite complex of chilli

The field experiment was conducted at SRC, Bogra during Rabi season of 2014-15 to develop an integrated management approach against thrips-mite complex of chilli. The treatments were 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. Spraying of Chlorphenapyr (Intrepid 10SC) @ 1ml/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 (33.02). The highest percentage of thrips(87.02%) and mite (87.32%) population reduction over control with maximum red ripe chilli yield (12.72 t/ha) was also obtained from Chlorphenapyr + White sticky trap. Thrips and mite populations are 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 Chlorphenapyr + White sticky trap treated plot followed by White sticky trap + Abamectin + Spinosad (22.75% and 25.15%) 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 Chlorphenapyr may be recommended for effective management of thrips-mite complex in chilli.

Ginger

Varietal Development

RYT of promising ginger lines

The experiment was conducted at Spices Research Center, Bogra (L_1); Spices Research Sub Center, Lalmonirhat (L_2); Hill Agricultural Research station Ramghar (L_3) and Regional Spices Research Center, Magura (L_4) during April 2014 to February 2015. Five promising ginger lines (G005, G006, G0027, G0024 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. Significant differences among the ginger lines were observed in each location regarding different parameters. In case of location, the highest yield (31.9 t/ha) was recorded at SRC, Bogra. The lowest yield was recorded (16.8 t/ha) at Ramghar location. In case of advance line, the highest yield (29.03 t/ha) was found from G005 while the lowest (19.84 t/ha) was found from G006. The Combined effect of location × advance line gave significant effect on yield and other parameter. The highest yield (36.03 t/ha) was obtained from G005 with Bogra location, while the lowest yield (8.37 t/ha) was obtained from BARI Ada-1 with Ramghar location. Significantly higher plant height, number of tillers/plant, number of leaves/plant and secondary rhizome, dry matter (%) and yield along with better yield contributing characters were observed from the line G005. In case of combined effect the highest dry matter (30.87%) was found from G005 in Bogra location. The lowest dry matter (16. 0%) was obtained from G0024 at Magura location.

Study of the genetic diversity of ginger

D^2 analysis of 20 ginger lines and analysis of variance were done. The lines were grouped into five clusters. The inter-cluster distance was larger than the intra-cluster distances. The maximum inter-cluster distance was ound between cluster I and II (37.22) followed by cluster III and IV (34.68) and III and V (25.04). It may be concluded that the line in cluster I (G0035, G0034) and the line in cluster II (G0021) grouped here could be used for future breeding work.

Induced mutagenesis on ginger for improved yield components

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2014 to February, 2015 to create variability and improve the yield components of existing ginger cultivars in

Bangladesh. The healthy rhizomes of one variety, BARI Ada-1 (V_1) and one promising line, G0025 (V_2) were exposed to gamma rays at different levels of doses (0, 5, 10 and 15GY) was considered as treatment in this investigation. The gamma radiation emitted from Cobalt-60 source and derived from Gammacel 220 was carried out at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The treated rhizomes were planted on April 22 , 2014 as M_1 generation followed by Randomized Complete Block Design with three replications. The crop was harvested on 8 February, 2015 when all the plants started drying. The maximum number (54 in V_1 and 45 in V_2) of survival plants at 60 DAP was recorded when rhizomes were exposed to 5 GY gamma ray. The number of primary (15 in V_1 and 18 in V_2), secondary (12 in V_1 and 13 in V_2) rhizomes and yield /plant (350g in V_1 and 500 g in V_2) were found maximum when exposed to 5GY Gamma ray compared to 10 GY and control. All the harvested M_1 ginger clones were kept in pit separately for production of M_2 generation in the next year.

Insect pest and disease management

Management of rhizome rot of ginger through chemicals and biocontrol agents

The experiment was conducted in heavily infected sick plot with rhizome rot disease at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out suitable control measures of rhizome rot disease of ginger. Seven treatments including control were used in this experiment. The crop variety was BARI Ada-1. The lowest infected plants (27.96%) at 95 DAP was recorded in T_2 (Soil drenching with Ridomil gold (0.3%), first drenching was done during planting, there after, drenching was continued at 30 days interval starting from 45 DAP) which was followed by T_1 (Soil drenching with Ridomil gold (0.3%), first drenching was done during planting, thereafter, drenching was continued at 15 days interval starting from 45 DAP) and T_4 (Soil applying with Trichoderma harzianum compost during planting, first and second earthing up @1.5 t/ha). The highest infected plants (44.88%) was obtained from untreated control at 95 DAP, After 95 DAP, the treatments did not work on rhizome rot of ginger. So, the yield data was not able to record.

Integrated management of rhizome rot of ginger

The experiment was conducted in heavily infected sick plot with rhizome rot disease at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out the control measure of rhizome rot disease of ginger through an integrated management. Eight management practices including control were used in this experiment. The crop variety BARI Ada-1 was used in this experiment. The lowest infected plants (24.75%) at 95 DAP was recorded in T_4 (Soil application with Stable bleaching powder during planting and 1st earhing up @20 kg/ha) + Seed treatment and soil drenching during 1st and 2nd earhing up with Ridomil gold (0.3%) + Trench surrounding the bed) which was followed by T_3 (Soil application with Stable bleaching powder during planting and 1st earhing up @20 kg/ha) + Seed treatment and soil drenching during 1st and 2nd earhing up with Ridomil gold (0.3%). The highest infected plants (47.15 %) was obtained from untreated Control at 95 DAP. After 95 DAP, the treatments did not work on rhizome rot of ginger. So, the yield data was not able to record.

Development of management option (s) against rhizome rot of ginger

A field experiment was laid out in the research field of Regional Spices Research Centre, BARI, Gazipur during 2014-2015 cropping season to find out the suitable management option(s) against rhizome rot of ginger. BARI Ada-1 was used as test crop. Six treatments including control were arranged in Randomized Complete Block Design with three replications. The treatments were T_1 = application of Neem oil cake (NOC) @300 kg/ha during planting + basal application of Ridomil Gold 68 WG (RG) @ 3.5 kg/ha (starting from first symptoms expression), T_2 = application of Neem oil cake (NOC) @ 300 kg/ha during planting + Neem oil cake (NOC) @ 300 kg/ha (starting from first symptoms expression), T_3 = basal application of Ridomil Gold 68 WG (RG) @ 3.5 kg/ha during planting + Ridomil Gold 68 WG (RG) @ 3.5 kg/ha (starting from first symptoms expression), T_4 = application of Neem oil cake (NOC) @300 kg/ha during planting, T_5 = basal application of Ridomil Gold 68 WG (RG) @ 3.5 kg/ha during planting and T_6 = control. Among the management options, application of Neem oil cake (NOC) @300 kg/ha during planting + basal application of Ridomil Gold 68 WG (RG) @ 3.5 kg/ha (starting from first symptoms expression (T_1) showed the lowest percentage (28.31 %) of Pseudostem damage and the highest percentage (40.85 %) of Pseudostem damage occured in control. The highest marketable yield (5.56 t/ha) was observed in NOC + RG (T_1) treated plot and lowest from control (1.60 t/ha).

Agricultural Economics

A study on production and price relationship for ginger in Bangladesh: an analysis by using distributed lag model

The study was conducted to aim at the determination of fluctuation, and production-price relationship of ginger in Bangladesh. The experiment was carried out by using ginger cultivation area, production and prices data from Bangladesh Bureau of Statistics (1975-2013). 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 ginger was identified which was between -50 to 63 percent while the extend of fluctuation of area, production and yield ranged between -5 to 13, -17 to 22 and -20 to 11 percent respectively during the study period. According to the results, ginger 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 ginger prices in Bangladesh to have an effect on ginger production is 19.83 years. This result shows that the farmers are very enthusiastic for growing this crop, which is largely grown as a major spice crop. 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 ginger which caused fluctuation more, sustainable ginger farming and establishment of an efficient marketing organization is a necessity.

Marketing and value chain analysis of ginger: a study in selected areas of Bangladesh

The study was undertaken to determine marketing system, marketing cost, margin, efficiencies and to examine the value chain of ginger aiming to determine the value addition in different steps of ginger marketing channel. Primary data were used for this study, collected from Nilphamari and Lalmonirhat depending upon the concentration of production and commercially marketing of ginger and consuming area Dhaka and Rajshahi. Data were analyzed using marketing margin, profit and efficiency ratio and value addition. Four major marketing channels were identified for domestic produced ginger marketing. Channel-3 was the most important supply chain through which 48% domestic produced ginger reaches to consumers. Marketing costs for each 100 kg of ginger were estimated from Tk 86.92 to 339.77 and marketing margin Tk 674.00 to 1820.00, respectively for different intermediaries. Marketing margin and profit were the highest in retailer than those of other intermediaries. Out of four marketing channel, Channel-4 was more efficient than those of other channels. Six actors like; farmer, local trader, trader, commission agent, wholesaler, retailer and consumer are identified who are involved in the ginger value chain. The study revealed that farmer added the highest amount of value Tk 2062.00 per 100 kg ginger followed by retailers (Tk 1820.00), Trader(Tk 835.00), local trader (Tk 690.00) and wholesalers (Tk 674.00) respectively. Eleven marketing problem were identified, among them price fluctuation, high transport cost and lack of loan facilities were the major problem. It is therefore, recommended that loan facilities should be provided to the intermediaries, IT service should be developed up to village level and transportation cost should be kept reasonable.

Turmeric

Varietal Development

On farm trial of turmeric variety

The experiment was conducted during April, 2014 to February, 2015 to evaluate the performances of turmeric variety at different agro-ecological zones and to popularize new turmeric variety at different locations among the farmers to promote their adoption. Two turmeric variety viz., BARI Holud-4 (V_1) and BARI Holud-5 (V_2) including local (V_3) as check were tested at six locations, viz., Mymensingh (L_1), Faridpur(L_2), Nilphamari (L_3), Comilla (L_4), Pabna (L_5) and Banderban (L_6). Planting was done on April, 2014 and the crop was harvested on February, 2015 when all the plants started drying. Turmeric varieties across all locations showed significant differences. Maximum number (2.96), heaviour mother rhizome (163.0g) and fingers (209.35 g), rhizome per clump (380.10g) and maximum yield (21.45 t/ha) was recorded in BARI Holud 4. Yield and yield contributing characters of varieties were tested in six locations were also found significant. The turmeric varietal performances at Comilla regarding different yield contributing characters, viz., plant height (126.63 cm), no. of tillers (4.43), number of fingers (24.76), weight of fingers (206.47g) , weight of mother rhizome (161.30g), weight of rhizome (423.50 g) and yield (25.34 t/ha) were found highest. Different yield contributing characters varied significantly regarding variety × location effect. BARI Holud 4 gave the heaviour finger (275.40g), mother rhizome per clump (199.80 g), rhizome (494.50 g) with maximum yield (27.54 t/ha) at Comilla location.

Evaluation of turmeric lines

The experiment was conducted at Regional Spices Research Center, Gazipur during April, 2014 to February, 2015. Six turmeric lines including BARI Holud-5 were considered for evaluation in this trial. Fingers were used as planting material and planted on April 20, 2014. The crop was harvested on February 25, 2015 when all the plants started drying. Range, Mean, Standard Deviation and CV(%) for plant height, number of leaves, number of tillers, number of fingers, number of mother rhizomes , weight of fingers (g), weight of mother rhizome (g) ,weight of rhizome (g) and yield(t/ha) of turmeric plants were calculated. Maximum co-efficient of variation was found in number of leaves (30.61%) followed by weight of mother rhizome (28.85%) and number of tillers (24.81%). Hence, there is a scope to select potential suitable plant/line for the next year trial. T0104-2 possessed the longest plant (151 cm), maximum number of leaves (54), tillers (9), fingers (46) and mother rhizome (5.6). The heavier finger (400 g) and rhizome (700 g) and highest yield (27.08 t/ha) were also recorded from this line. The core color was found attractive (Yellow- Deep yellow-orange yellow) in all lines. All turmeric lines including BARI Halud-5 having disease grade scale 1.00 for leaf blotch disease except T073-1 (2.00).

Insect pest and disease management

Screening of turmeric lines /varieties against leaf blotch disease

An experiment was conducted during 2014-2015 at Spices Research Centre, Shibgonj, Bogra to find out the resistant/tolerant lines of turmeric against leaf blotch disease. A total eighteen lines of turmeric were used in the experiment. A susceptible check BARI Halud -1 was used in the experiment. Among the eighteen lines only T098-1 line showed moderately resistant against leaf blotch disease. The highest rhizome yield (29.55 t/ha) was recorded from T0125 but different significantly from other lines/varieties. The line T098-1 gave the second highest yield (24.23 t/ha).

Efficacy of fungicides in controlling leaf blotch of turmeric

The experiment was conducted at Spices Research Centre, Shibgonj, Bogra during April 2014 to February 2015 to find out the effective fungicide(s) in controlling leaf blotch of turmeric. Eight fungicides namely Sunvit, Zineb, Ridomil gold, Bavistin, Antracol, Bordeaux mixture, Tilt-250 EC, Cabrio Top along with control (no spraying) were included as treatment. The experiment was laid out in Randomized Complete Block Design with three replications. Among the fungicides the lowest (13.15) percent disease index (PDI) was recorded in CabrioTop treated plot and the highest (44.53) percent disease index was recorded in control plot. Leaf area diseased was lowest (12.28) in Cabrio Top treated plot and the highest (48.07) was recorded in control plot. Significantly the highest (69.50) percent disease reduction over control was found in Cabrio Top treated plot and the lowest (30.48) was in Bordeaux mixture treated plot. The highest yield (36.13 t/ha) was obtained from Cabrio Top treated plot which differed significantly from other treatments. The lowest yield (17.13 t/ha) was recorded in control plot.

Efficacy of fungicides in controlling leaf spot of turmeric

A field experiment was laid out in the research field of Regional Spices Research Centre, BARI, Gazipur using fingers of BARI Halud-1 during 2014-2015 cropping season to evaluate the efficacy of some fungicides in controlling leaf spot of turmeric. Nine treatments (Eight fungicides and one control) were arranged in Randomized Complete Block Design with three replications. Among the fungicidal treatments Contaf 5 EC showed the best performance in reducing the disease as well as increase the yield (35.45 t/ha).

Coriander

Varietal Development

Evaluation of coriander germplasm

The trial was conducted at Spices Research Centre, BARI Shibgonj, Bogra during rabi season 2014-2015 to evaluate the collected genotypes and to identify the best line(s) with higher yield and other desirable characters. Seventeen different coriander genotypes were evaluated based on some morphological traits and seed yield with BARI Dhonia1as a check. The maximum variation was found in plant height (cm), number of branches/plant, number of umbels/plant, number of umbel lets/umbel, number of seeds/umbel, number of seeds/umbel let, 1000-seed weight (g) and seed yield (t/ha). On the basis of D^2 analysis, seventeen genotypes were grouped into five clusters. The inter-cluster D^2 values varied from 4.663 to 21.095 exhibited medium range of diversity presence in the genotype. Maximum inter-cluster distance was found between cluster I and V (21.095) followed by cluster I and II (18.486), I and III (17.726) and I and IV (18.297). The genotype of these clusters could be used in future breeding program.

Black cumin

Varietal Development

Evaluation of black cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibgonj, Bogra during rabi 2014-2015 to evaluate the collected genotype and to identify the best line(s) with higher yield and other desirable characters. Ten different black cumin genotypes were evaluated in terms of their yield and yield contributing characters. The maximum variation was found in plant height (cm), number of branches/plant, number of capsules/plant, number of seeds/capsule, capsule length, capsule width, 1000-seed weight (g) and seed yield (kg/ha). On the basis of D^2 analysis, ten genotypes were grouped into four clusters. The inter-cluster D^2 values varied from 5.877 to 18.302 exhibited medium range of diversity presence in the genotype. The maximum inter-cluster distance was found between cluster I and IV (19.624) followed by cluster III and IV (12.255) and I and II (11.876). Number of branches/plant, number of seeds/capsule, capsule length and 1000-seed weight (g) are the major role played for diversity of cumin genotypes. The superior genotype which based on morphological characters and seed yield of these clusters could be used in future breeding program.

Cultural Management

Effect of seed rate and sowing method on the yield of black cumin

The research was carried out at the research field of Spices Research Centre, Shibganj, Bogra during rabi season, 2013-14 and 2014-15 to determine optimum seed rate and suitable sowing method for black cumin cultivation. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a Randomized Complete Block Design (factorial) with three replications. Four different seed rates viz. 4, 6, 8 and 10 kg seed/ha and three sowing methods viz. Broadcasting without bed, Line sowing without bed and Line sowing in raised bed were compared during 2013-14. In 2014-15, treatments regarding seed rates were similar but one additional treatment like broadcasting in raised bed was included to the above sowing method. The highest seed yield (1063 kg/ha in 2013-14 & 1221 kg/ha in 2014-15) was obtained from treatment combination of 8 kg seed/ha x line sowing in raised bed. Which was identical to 10 kg seed/ha x Line sowing in raised bed (976.9 kg/ha in 2013-14 & 1135 kg/ha in 2014-15), followed by 10 kg seed/ha x Line sowing without bed (959.7 kg/ha in 2013-14 & 1070 kg/ha in 2014-15) and 10 kg seed/ha x Broadcasting in raised bed (1067 kg/ha in 2014-15). The lowest seed yield (218.8 kg/ha in 2013-14 & 517.3 kg/ha in 2014-15) was recorded from 4 kg seed/ha x Broadcasting without bed method.

Fenugreek

Varietal Development

Evaluation of fenugreek germplasm

The trial was conducted at Spices Research Centre, BARI Shibgonj, Bogra during rabi, season of 2014-2015 to evaluate the collected genotype and to identify the best line(s) with higher yield and other desirable characters. Seventeen different fenugreek genotypes were evaluated based on some morphological traits and seed yield with BARI Methi 2 as a check. The maximum variation was found in plant height (cm), number of branches/plant, number of pods/plant, pod length (cm), number of seeds/pod, 1000-seed weight (g) and seed yield (t/ha). On the basis of D^2 analysis, eighteen genotypes were grouped into five clusters. The inter-cluster D^2 values varied from 4.557 to 10.113 exhibited medium range of diversity presence in the genotype. The maximum inter-cluster distance was found between cluster IV and V (10.113) followed by cluster I and V (9.303). The genotypes of these clusters could be used in future breeding program.

Cultural Management

Effect of row spacing and phosphorus doses on yield and yield attributes of fenugreek (Trigonella foenum-graecum)

The experiment was conducted at Spices Research Sub-Centre, Faridpur during rabi season 2013-14 and 2014-2015 to determine the effects of different row spacing (S_1=20, S_2=30 and S_3= 40 cm) and phosphorus applications (P_0 = 0, P_1 = 30, P_2 = 60 and P_3 = 90 kg ha^{-1}) on the yield and yield attributes of fenugreek. The two factor experiment was arranged in Randomized Complete Block Design with three replications. Phosphorus fertilizer applications positively affected all the traits examined except for 1st pod height, pod length and thousand seed weight. In 2013-14, the highest seed yield (2.23 t/ha) was obtained from 30 cm spacing with 90 kg P/ha. The lowest yield (0.73 t/ha) was obtained from S_3P_0 (40 cm spacing with control). In 2014-15, the row spacing of 20 cm and phosphorus dose of 90 kg/ha gave the highest yield (2.03 t/ha). The lowest yield (0.70 t/ha) was obtained from 40 cm spacing with 0 kg P/ha.

Nutrient Management

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

A field experiment was conducted at research field of Spices Research Centre, Shibgonj, Bogra during rabi season, 2014-2015 to evaluate the response of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.). The experimental site situated at 24°51′ N latitude and 89°22’ E longitudes belongs to the AEZ-3: Tista Karatoa flood Plain (FAO, 1988). It has sub-tropical climate with an average annual rainfall of 237.13 mm. The soil having pH 5.9. The experiment consisted of eight treatment combinations of integrated nutrient management. These were T_1 = Absolute control, T_2 = Chemical fertilizer (CF) on the basis of STB, T_3 = Cow dung (CD) @ 3 t/ha + CF (IPNS), T_4 = Poultry Manure (PM) @ 2 t/ha + CF (IPNS), T_5 = Vermicompost (VC) @ 1 t/ha + CF (IPNS),), T_6 = CD @ 5 t/ha + CF (IPNS), T_7 = PM @ 4 t/ha + CF (IPNS) and T_8 = VC @ 3 t/ha + CF (IPNS). The experiment was laid out in a randomized complete block design with three replications. Growth and yield attributes as well as seed and stover yields of fenugreek were significantly influenced by INM treatments. Results revealed that response of T7 = PM @ 4 t/ha + CF (IPNS) gave the higher growth attributes, (viz., plant height, branches/plant) and yield attributes viz., length of pod, pods/plant, seeds/pod and test weight, seed yield (2.1 t/ha) and biological yield (4.89 t/ha). This treatment was also superior in terms of N, P, K and protein content (%) in seed as well as in stover, total N, P and K uptake and available N, P and K after the harvest of the crop over other treatment combinations.

Fennel

Varietal Development

Evaluation of fennel germplasm

The trial was conducted at Spices Research Centre, BARI, Shibgonj, Bogra during rabi 2014-2015 to evaluate the collected genotype and to identify the best line(s) with higher yield and other desirable characters. Ten different fennel genotypes were evaluated in terms of their yield and yield contributing characters. The maximum variation was found in plant height (cm), number of branches/plant, number of umbels/plant, number of umbel lets/umbel, number of seeds/umbel let, 1000-seed weight (g) and seed yield (t/ha). On the basis of D^2 analysis, ten genotypes were grouped into four clusters. The inter-cluster D^2 values varied from 7.804 to 13.322 exhibited medium range of diversity presence in the genotype. The maximum inter-cluster distance was found between cluster II and IV (13.322) followed by cluster I and IV (13.024) and me and III (12.505). Number of umbel let/umbel, number of seeds/umbel let and seed yield (t/ha) are the major role played for diversity of fennel genotypes. The superior genotype which based on morphological characters and seed yield of these clusters could be used in future breeding program.

Regional yield trial of fennel

The experiment was conducted at Spices Research Centre, Bogra; Regional Spices Research Centre, Magura and Comilla, Spices Research Sub-Centre, Faridpur, Lalmonirhat, Agricultural research centre, Pahartoli, Chittagong and On Farm Research Division, Barind Rajshahi during 15th November 2014 to 10th and 24th April, 2015. Four promising fennel lines FN_{01}, FN_{03}, FN_{06} and FN_{07} were included in the study. The experiment was laid out in RCB design with four replications. Among the lines under study, it was observed that the fennel line FN_{01} and FN_{06} gave the highest yield (1.38 t/ha). The lowest yield (1.21 t/ha) was recorded on FN_{03}. In case of location, the highest yield (2.59 t/ha) was recorded in Comilla. Combined effect of location x line gave significant effect on all yield contributing characters except branch/plant. The highest yield (2.75 t/ha and 2.73 t/ha) was obtained from FN_{06} and FN_{07} at Comilla. The line FN_{01} and FN_{06} performed better in all location.

Cultural Management

Effect of sowing time and plant spacing on fennel seed production

The experiment was conducted at Spices Research Centre, Shibgonj, Bogra during rabi season, 2014-15 to find out the optimum planting time and plant spacing for maximizing seed yield of fennel. The experiment was laid out in RCB design with three replications. Three sowing time viz., 10 November, 20 November and 30 November and six plant spacing viz., 30cm x 10 cm, 30cm x 15 cm, 40 cm x 10 cm, 40 cm x 15 cm, 50 cm x 10 cm and 50 cm x 15 cm were compared to achieve the objectives. The highest seed yield (1.40 t/ha) was obtained from crops planted on 10 November which was identical to 20 November (1.33 t/ha) and the lowest seed yield was recorded from 30 November sowing (1.08 t/ha). The highest seed yield was found (1.51 t/ha) from 40 cm x 10 cm spacing which differed significantly from other treatments. The highest seed yield (1.67 t/ha) was recorded from crops grown on 10 November along with 40 cm x 10 cm spacing which differed significantly from other treatments.

Nutrient Management

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

A field experiment was conducted at Spices Research Centre, Shibgonj, Bogra during rabi season, 2013-14 and 2014-15 to develop irrigation schedule for higher yield of fennel and to rationalize the N fertilizer rate under the available water supply. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a split- plot design with three replications. In 2013-14, eight levels of Irrigations viz., 01 irrigation at 4-5 leaf stage, 02 irrigations at 4-5 leaf + BI, 02 irrigations at BI + FL stage, 02 irrigations at 4-5 leaf + GF stage, 02 irrigations at BIS + FL stage, 03 irrigations at 4-5 leaf + BI + FL stage, 03 irrigations at BI + FL+ GF stage and 04 irrigations at 4-5 leaf + BI + FL +GF stage were assigned to the main-plot and five levels of Nitrogen viz., 0, 30, 60, 90 and 120 kg/ha were assigned to the sub-plot. In 2014-15, another main plot treatment - 02 irrigations at 4-5 leaf + FL stage was included to the above treatments. Seed yield of fennel varied significantly due to different irrigation treatments. The highest seed yield (2.37t/ha in 2013-14 & 2.18 t/ha in 2014-15) was obtained from 4 irrigations at 4-5 leaf + BI +FL +GF stage which differed significantly from other treatments. The lowest seed yield was recorded from one irrigations at 4-5 leaf stage (0.96 t/ha in 2013-14 & 0.73 t/ha in 2014-15). In 2013-14, the highest seed yield (2.11t/ha) was obtained from 120 kg N/ha which was identical to 90 kg N/ha (2.03 t/ha) but differed significantly from other N levels. The seed yield obtained from 2014-15 showed similar trend as in 2013-14.The lowest seed yield was recorded from crop grown without N (0.86 t/ha in 2013-14 & 0.91 t/ha in 2014-15). The interaction between Irrigation x Nitrogen was found significant. In 2013-14, the highest seed yield was recorded with 4 irrigations x 120 kg N/ha (2.97 t/ha) which was identical to 4 irrigations x 90 kg N/ha (2.87 t/ha). The interaction between Irrigation x Nitrogen showed similar trend of result in 2014-15.

Insect pest and disease management

Identification of diseases and isolation of pathogens of fennel

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to identify and isolate of pathogens of different diseases of Fennel. Diseased plant samples having typical symptoms were collected from the different experimental fields of Spices Research Centre, Shibganj, Bogra for isolation of causal pathogens of different diseases of Fennel. Isolated and identified pathogen of umbel blight of Fennel was *Alternaria brassicicola*, which was purified by using PDA. Data on Fennel diseases were recorded from different 10 Fennel lines. Among the Fennel lines, wilt incidence was very poor ranged from 0-5%. Alternaria leaf and umbel blight ranged from 11.00-31.33%, while the lowest leaf and umbel blight was obtained from Fennel line FN 09 which was statistically similar to FN_{03} (11.67%) and FN_{07} (14.00%), and the highest severity was obtained from FN_{10} which was statistically identical to FN_{06} (27.67%) and FN_{02} (28.33%).

Ajowan

Varietal Development

Collection and evaluation of ajowan germplasm

The experiment was conducted at Regional Spices Research Center, BARI, Gazipur during Rabi season of 2014-15 to assess the performance of Ajowan germplasm based on agronomical and morphological characteristics. Three populations collected from different regions were germinated and evaluated on various agronomical and morphological characteristics. The Line TC GAZ 001 gave early flowering (59 days) and higher seed yield (630 kg/ha) while the line TCGAZ003 was delayed flowering (73 days) and gave lower seed yield (291.7 kg/ha).

Bay leaf

Varietal Development

Evaluation of bay leaf germplasm (*Cinnamomum tamala*)

The trial was conducted at Spices Research Centre, BARI Shibgonj, Bogra during kharif season of 2013-2014. Four different bay leaf lines were evaluated in terms of their leaf yield and yield contributing characters. Among the lines CTB 004 produced the highest leaf length (15.50 cm in 2013 and 15.75 cm in 2014), highest leaf breath (5.75 cm in 2013 and 5.85 cm in 2014), lowest internodes distance (3.03 in 2013 and 3.31 cm in 2014), the highest leaf thickness (0.70 mm in 2013 and 0.71mm in 2014), the highest dry matter (52.79% in 2013 and 54.16% in 2014), highest petiole length (1.32cm in 2013 and 1.5 cm in 2014) and the lowest disease incidence (6.79% in 2013 and 7.44% in 2014) was recorded from CTB 004 and the highest leaf yield (green) (35.2 kg/plant/year) in 2013 and 38.18 kg/plant/year in 2014) was also obtained from CTB 004.

Evaluation of bay leaf germplasm at Jaintapur

The study was conducted at spices research sub-station, Citrus Research Station, BARI, Jaintiapur, Sylhet during July, 2014 to May, 2015 to find out a suitable germplasm as variety. Three bay leaf germplasm CT Jai-001, CT Jai-002 and CT Jai-003 were selected for the study. A wide variability was observed in different parameters such as pungency and size of leaf, yield, pest and diseases infestation among the germplasm studied. CT Jai-001 was superior with biggest leaf followed by CT Jai-003. Among the accessions CT Jai-001 also gave highest yield but leaf aroma was higher in CT Jai-003. But CT Jai-002 gave the higher arema.

Cultural Management

Study on multiplicaton techniques of bay leaf (*Cinnamomum tamala*)

The trial was conducted at Spices Research Centre, BARI Shibgonj, Bogra during kharif season (July to august of 2014. Four different bay leaf lines and four different propagation techniques were applied for suitable multiplication in terms of sapling establishment (duration) and percentage of success. Lowest duration 19.33 days of sapling establishment was recorded from CTB 003 lines. The maximum 88.25 percent bay leaf sapling successfully establish at approach grafting methods.

Insect pest and disease management

Management of leaf gall in bay leaf (*Cinnamomum tamala*)

A field experiment was conducted at SRC, Bogra during kharif season 2014-15 to determine the best performing management option against leaf gall forming Eriophyid mite in bay leaf. Among different treatments, spraying of Abamectin (Vertimec 1.8 EC) @ 1.2ml/l of water performed better followed by spraying of Chlorfinapyr (Intrepid 10 EC) @ 1ml/L of water and spraying of spinosad (Tracer

45SC) @ 0.4 ml/L of water over other treatments in respect of mite population reduction. Pruning alone was modestly effective in keeping the plants gall free. Among the treatment unsprayed control plant observed moderate to severe injury compared to other treatments. Abamectin (Vertimec1.8EC) @ 1.2 ml/l of water treated plant showed trace injury level against mite infestation. Lowest percentage of infested leaves per shoot (13%) was recorded in Abamectin (Vertimec 1.8 EC) treated plant followed by Chlorfinapyr (Intrepid 10 EC) treated plant (17%) and Spinosad (Tracer 45 SC) treated plant (22%). The highest percentage of infested leaves per shoot (62%) was recorded in unsprayed control plant.

Management of grey leaf spot/blight disease of bay leaf (*Cinnamomum tamala*)

The experiment was conducted at Spices Research Centre, Shibgonj, Bogra during December, 2014 to May, 2015 to determine the best management option against grey leaf spot disease of bay leaf. Five fungicides namely Tilt-250 EC, Combi-2, Bavistin, Sunvit, Nativo, one botanical extract namely eucalyptus leaf extract and one chemical fertilizer (MoP) along with control were used in this study. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The lowest (19.42) number of diseased leaves/twig was recorded in T7 {Tilt-250 EC + top dressing of MoP (200 g/plant)} and highest (108.2) number of diseased leaves/twig was recorded in control plant. The highest (47.18%) percent leaf area diseased was recorded in control plant where as the lowest (8.45%) leaf area diseased was recorded in Tilt treated plant. The highest fresh leaf yield (23.83 kg/plant) was obtained from T_7 treated plant and the lowest fresh leaf yield (7.42 kg/plant) was recorded from control plant.

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

The trial was conducted at Spices Research Centre, BARI Shibgonj, Bogra during 2014-2015 to find out the resistant/tolerant lines of bay leaf against leaf spot and grey leaf spot diseases. A total of four lines of bay leaf (CTB 001, CTB 002, CTB 003 and CTB 004) were used in the experiment. Among these lines, one line, CTB 003 showed resistant, two lines viz., CTB 001 and CTB 004 showed moderately susceptible against leaf spot and grey leaf spot disease. The highest fresh yield (35.02 kg/plant) was obtained from CTB 004.

Cinnamon

Varietal Development

Evaluation of cinnamon germplasm

The study was conducted at Regional Spices Research Center, BARI during May, 2014 to April 2015 to evaluate the tree growth, leaf characteristics, bark thickness, specific bark weight and quality of bark of the present cinnamon plants. Descriptive statistics on 30 different parameters showed variations of 53 cinnamon plants. Different growth parameters with tree volume differed from plant to plant having different ages. 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. Different parameters showed significant correlation among growth parameters as well as bark characteristics.

Cumin

Varietal Development

Evaluation of cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibgonj, Bogra during rabi 2014-2015 to evaluate the collected genotype and to identify the best line(s) with higher yield and other desirable characters. Ten different cumin genotypes were evaluated in terms of their yield and yield contributing characters. The maximum variation was found in plant height (cm), number of branches/plant, number of umbels/plant, number of umbel lets/umbel, number of seeds/umbel, number of seeds/umbel let, 1000-seed weight (g) and seed yield (kg/ha). On the basis of D^2 analysis, ten genotypes were grouped into four clusters. The inter-cluster D^2 values varied from 4.685 to 19.624 exhibited medium range of diversity presence in the genotype. The maximum inter-cluster distance was found between cluster I and III (19.624) followed by cluster II and III (15.388) and I and IV (10.752). Number of umbels/plant, number of seeds/umbel and number of seeds/umbel let are the major role played for diversity of cumin genotypes. The superior genotype which based on morphological characters and seed yield of these clusters could be used in future breeding program.

Insect pest and disease management

Effect of fungicides in controlling wilt disease of cumin

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out the effective fungicides in controlling wilt disease of cumin. The treatments were five fungicides viz. Sunvit 50 WP @ 0.5%, Secure @ 0.02%, Rovral 50 WP @ 0.2%, Bavistin DF @ 0.25%, Provax 200 WP (0.25%) and one control (untreated). Cumin line CN 026 was used in the experiment. Wilt incidence ranged from 13.45 - 37.69%, while the lowest incidence was recorded In Bavistin treated plots which was statistically similar to Provax and Sunvit, and the highest incidence was recorded in control. Bavistin (0.25%) gave the highest number of umbels/plant, number of umbel lets/plant, number of seeds/umbel, number of seeds/plant, weight of eeds/plant and seed yield (586.5 kg/ha) which was followed by Provax and Sunvit, and the lowest of these parameters were obtained from control treatment.

Effect of fungicides in controlling Alternaria Blight of cumin

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out the effective fungicides in controlling Alternaria blight of cumin. Four fungicides viz. Rovral 50 WP @ 0.2%, Companion @ 0.2%, Secure 600 W @ 0.15%, Sunvit 50 WP @ 0.5% and one control were used as treatment. Cumin line CN 026 was used in this experiment. Three fungicides reduced disease significantly over control. Alternaria blight ranged from 14.40 - 90.81%, while the lowest severity was recorded in Rovral 50 WP (0.2%) sprayed plots and the highest severity was recorded in control treatment. Rovral 50 WP (0.2%) gave the highest number of umbels/plant, number of umbel lets/plant, number of seeds/umbel, number of seeds/plant, weight of seeds/plant and seed yield (675.0 kg/ha) which was followed by Companion and Secure 600 w. Sunvit and control treatment did not produce any seeds.

Betel leaf

Varietal Development

Evaluation of betel leaf germplasm

This experiment was conducted at Spices Research Centre, BARI, Shibgonj, Bogra during July, 2014 to May, 2015 to select the promising betel leaf germplasm for releasing a variety. Twelve different betel leaf lines/varieties were evaluated based on their yield and other desirable characters. Among the lines, highest (232.80 cm^2) leaf area was recorded from BL 003 and the lowest (140.70 cm^2) in BL 002 during kharif-2. In case of rabi, the highest leaf area (196.90 cm^2) was recorded from BL 003 and the lowest leaf area (121.20 cm^2) in BL 0016. The maximum number of leaves (41.62 lakh/ha/year) was recorded from BL 003 and the minimum number of leaves (29.01 lakh/ha/year) was recorded in BL 008. The highest leaf (fresh) yield (23.27 t/ha/year) was recorded in BL 003 and the lowest leaf (fresh) yield (11.85 t/ha/year) was recorded from BL 002 and BL 008.

Nutrient Management

Effect of N, P and K on the yield and quality of betel leaf

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during kharif season 2013-14 and continued in 2014-15 to determine optimum dose of N, P and K in combination with organic & inorganic source and to assess the effect of N, P and K on the yield and quality of betel leaf. The land was medium high and the soil was silty loam in texture. The experiment was laid out in a Randomized Complete Block Design with three replications. Different fertilizer doses viz. N = 0, 50, 100, 150 kg/ha, P = 0, 22, 44 kg/ha and K= 0, 21, 42 kg/ha were considered as treatment. The treatment combinations were $T_1 = N_0P_0K_0$, $T_2 = N_0P_{22}K_{21}$, $T_3 = N_{50}P_{22}K_{21}$, $T_4 = N_{100}P_{22}K_{21}$, $T_5 = N_{150}P_{22}K_{21}$, $T_6 = N_{150}P_{44}K_{21}$, $T_7 = N_{150}P_{44}K_{42}$, $T_8 = N_{100}P_0K_{21}$, $T_9 = N_{100}P_{44}K_{21}$, $T_{10} = N_{100}P_{22}K_0$ and $T_{11} = N_{100}P_{22}K_{42}$. The total amount of N as per treatment was top dressed in 8 equal splits at 45 days interval. The sources of N were 50% from Urea and 50% from mustard oil cake. Betel leaf advanced line BL-018 was used as a test crop. The highest leaf yield (59000 bira/ha in 2013-14 & 142200 bira/ha in 2014-15) was obtained from the treatment $T_{11} = N_{100}P_{22}K_{42}$ which was identical to $T_9 = N_{100}P_{44}K_{21}$ (55370 bira/ha in 2013-14 & 123500 bira/ha in 2014-15) and $T_4 = N_{100}P_{22}K_{21}$ (51590 bira/ha in 2013-14 & 120600 bira/ha in 2014-15). The lowest leaf yield (26030 bira/ha in 2013-14 & 57090 bira/ha in 2014-15) was recorded from $T_1 = N_0P_0K_0$ (1 bira = 80 leaves).

Black pepper

Cultural Management

Studies on multiplication methods of black pepper (*Piper nigrum l.*) Var. Jaintia gol morich under jaintapur condition

The experiment was conducted to study the effect of different propagation methods of black pepper (*Piper nigrum*) var. *Jaintia* Black Pepper at Spices Research Sub-station, Citrus Research Station, BARI, Jaintiapur, Sylhet from June' 2013 to May' 2015. The experiment consists of four different multiplication method as treatment viz. T_1 = Bamboo split method, T_2 = Soil mound method, T_3 = Serpentine method and T_4 = Traditional Method. The experiment was conducted in Randomized Complete Block Design with four replications. The vines in soil mound method exhibited superior performance with respect to length and root production/ node in both the years. The availability of cuttings from soil mound method was also the highest. The rooting percentage of cuttings obtained from soil mound and bamboo split method were significantly superior over traditional method of multiplication. The benefit-cost ratio for marketable black pepper sapling by soil mound method was the best (1.91 in 2013-14 and 2.13 in 2014-2015).

Plum

Cultural Management

Effect of IBA concentration on the success of cutting and air layering of plum

Experiments were conducted at the Regional Spices Research Center, BARI, Gazipur during January 2013 to August 2014 to evaluate the effect of IBA concentration and time of cutting and air layering of plums. Cutting were placed with six levels of IBA treatments Viz 0, 500, 1000, 1500, 2000 ppm and dusting. Profuse shoot growth was observed but no root was emerged in cuttings and all cuttings were died after a few (25-30) days. Air layering was done in four time (Mid-June, Mid-July, Mid-August and Mid September) with five levels of IBA Significant variations on death of layers, rooting and leaf production due to layering time with six IBA concentrations (0, 500, 1000, 1500, 2000 ppm and dusting) was observed. Layering time and IBA concentration showed significant effect on rooting and success rate of layers. The number of successful layer was significantly higher in June (14.3, 57.33%) and July (13.3, 53.33%) layering with 2000 ppm IBA application and the success was nil (0.0) in September layering without or lowest (500 ppm) concentration of IBA.

Dill

Nutrient Management

Effect of N,P, K and S on the growth and yield of dill

The experiment was carried out at the research field of Spices Research Centre, Shibgonj, Bogra during the Rabi season of 2014-2015 to determine the standard fertilizer dose to obtain higher yield of dill (local dill line). The experiment was laid out in a randomized complete block design with 14 fertilizer combinations of treatment 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. Response of N was more pronounced in comparison to P and K. The maximum seed yield (2.30 t/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. 75606/ha) and benefit cost ratio (2.21) was also obtained from the same treatment T_{10} ($N_{90}P_{35}K_{50}S_{20}$ kg/ha). The highest net return (Tk. 79806/ha) and benefit cost ratio (2.28) was also obtained from the same treatment (T_5). The yield benefit for the best treatment over the control was 157.61%. The 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 appears to be the best treatment for maximizing the seed yield of dill.

Identification of diseases and isolation of pathogens of cumin, black pepper and cardamom

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to identify and isolate of pathogens of different diseases of cumin, black pepper and cardamom. Diseased plant samples having typical symptoms were collected from the different experimental fields of Spices Research Centre, Shibganj, Bogra for isolation of causal pathogens of different diseases of cumin, black pepper and cardamom. Isolated and identified pathogen of umbel blight of cumin, black pepper and cardamom were purified by using PDA. Data on Cumin diseases were recorded from different Cumin lines. Among the Cumin lines, the lowest wilt incidence (12.00%) was observed in Cumin line CN 16 and the highest incidence (27.33%) was recorded in Cumin line CN 17. Significantly the lower leaf blight severity (1.20%) of Black pepper was recorded from the month of May and the highest severity (8.40%) was observed in the month of November. Algae leaf spot/red rust severity of Black pepper ranged from 1.30-8.30% while the lowest severity was obtained from the month of March and the highest severity was obtained from the month of October. Leaf spot/blight disease severity of Cardamom ranged from 8.00-25.60% while the lowest severity was obtained from the month of May and the highest severity was obtained from the month of October.

All spice

Post harvest technology

Development of products from all spice (*Pimenta dioica*) leaves and its sensory evaluation

The experiment was concerned with the kinetics of dehydration of All Spice (*Pimentadioica*) leaves and development of All Spice products and its sensory evaluation. The All Spice leaves were treated with sodium chloride, sodium metabisulphite and hot water. Drying was done in two different ways: firstly, in a oven drying at constant temperature (40^0 C) and secondly, by sun drying (35-40^0 C). Drying time were around 72 hr for oven and sun drying. The effects of treatments, packaging materials and storage time on the keeping quality of the all spice powder was evaluated. For conducting organoleptic taste test osmosed, blanched and sulphited dehydrated all spice powder packed in HDPE bag and stored at RT, the results for colour, smell, crispness and overall acceptability of 8 samples showed that the steam blanched all spice sun dried powder found best among other treated (osmosed , blanched and sulphited) and untreated sun and oven dried sample. In order to determine the suitability of blanched sun dried all spice powder in a curry, it was decided to conduct organoleptic taste test of chicken curry using 4 different samples. These are S_1: Normal spice (onion, garlic, ginger, turmeric, chilli, coriander, cumin) + blanched and sun dried all spice powder, sample no. S_2: Normal spice + all spice paste, sample no. S_3: was prepared with normal spice with Black pepper, nutmeg, cinnamon and clove (BNCC) (Control) and sample no. S_4: was prepared using onion, garlic, ginger, turmeric, chilli with all spice sun dried powder. It is concluded that sample S_1 and S_2 are undoubtedly the best samples (among the samples tasted) since these samples secured the highest scores for almost all quality attributes and were equally acceptable at 5% level of statistical significance. Samples S_2 however secured the highest numerical score for each attribute except texture of sample. The control (sample S_3) secured the third highest score for all attributes, while sample S_4 though secured the lowest score for all attributes. Statistically all the samples were equally acceptable but there were little differences in score among each attributes.

6 VEGETABLE CROPS

Eggplant

Varietal improvement

Genetic diversity of eggplant germplasm

A study was conducted with twenty seven eggplant germplasm at the experimental field of Olericulture Division, Horticulture Research Centre (HRC), BARI, Gazipur during the winter season of 2014-15 to assess the extent of genetic diversity in 27 eggplant germplasm which will help to select prospective parents to develop transgressive segregate. The collected germplasm originating from different local and exotic sources were subjected to cluster analysis. The germplasm were constellated into five distinct groups with the range of 2 germplasm in cluster II to 8 germplasm each in cluster IV and V. The inter-cluster distance in all cases was larger than the intra-cluster distance. Maximum inter-cluster distance (19.730) was observed between germplasm of cluster I and III followed by cluster II and III (15.189) and minimum was found between germplasm of cluster IV and V (4.975). The highest intra cluster value (1.090) was observed in cluster V. Mean performance of different clusters revealed that cluster I recorded the highest mean for average fruit weight (204.00 g), plant height at last harvest (92.33 cm), fruit diameter (8.30 cm) and the lowest desirable mean for days to first flowering (82.67 days), days to first harvesting (109.67 days), whereas maximum highest mean value for days required for fruiting (26.50), fruit yield per plant (2.90 kg), fruit yield per hectare (38.62 t) were in cluster II with desirable the highest or the lowest means. Therefore, inbreds belong to cluster I, cluster II, cluster II and cluster IV will be given higher priority for crossing in future eggplant hybridization programme.

Collection and evaluation of eggplant germplasm

The experiment was conducted at RARS, Jamalpur during the winter season of 2014-2015. Fifteen open pollinated brinjal germplasm viz. SMJam 001, SMJam 002, SMJam 003, SMJam 004, SMJam 005, SMJam 006, SMJam 008, SMJam 009, SMJam 010, SMJam 011, SMJam 013, SMJam 014, SMJam 015, SMJam 016 and SMJam 017 were evaluated at the experimental field of RARS, Jamalpur to evaluate the performance of collected eggplant lines. Days to 50% flowering differed and ranged from 68 to 95 days. Days to 1st harvest ranged from 101 to 144 days where the line SMJam 016 required minimum (101) days. The highest (160) number of fruits per plant was counted from the line SMJam013 and the lowest (7) number of fruits from SMJam015. Maximum yield (29.62 kg/plot and 42.31 t/ha) was produced by the line SMJam001 and minimum yield (8.32 kg/plot and 11.89 t/ha) was by SMJam 015.

Evaluation of purple coloured eggplant lines in winter

A study on the performance of thirteen eggplant lines/variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 20014-15 to study the performance of the selected purple fruited eggplant lines as well as to develop new purple coloured OP/ F_1 varieties. The line SM083-2 took minimum 97.3 days to first harvest. BARI Begun 10 produced the longest fruit (30.5 cm), while SM083-2 produced maximum diameter fruit (6.43 cm). The line SM058C produced the highest marketable fruit number per plant (25.2),and the lowest

(13.58) was produced by SM 203. While the SM203 produced the heaviest fruit (218.5 g). The line SM232 produced significantly the highest yield (49.06 t/ha) closely followed by SM181 (45.78 t/ha), SM203 (39.54 t/ha), SM253 (36.14 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in SM269A (9.91%) followed by SM83-2 (10.54%). Five types of fruit shape were observed viz., cylindrical (3 germplasm/ variety), oblong (6 germplasm), long (2 germplasm) round and oval (1 germplasm each), while three types of colour within the purple colour were observed among the germplasm viz., purple (6 germplasm/ variety), light purple (4 germplasm), and deep purple (3 germplasm). The results of the present study revealed that the lines SM0232, SM181, SM203, SM075, SM217 and SM058C were found promising for earliness, high yield and pest resistance and may be recommended for PYT.

Preliminary yield trial of green coloured eggplant lines in winter

A study on the performance of ten eggplant lines/variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 20014-15 to study the performance of the selected green fruited eggplant lines as well as to develop new green coloured OP/ F_1 varieties. The line SM011 took minimum 95 days to first harvest. The lines SM083A, SM221B and SM253B produced the longest fruit (14.0 cm), while lines SM011 and SM259 produced the shortest fruit (7.0 cm). The line SM211B produced maximum marketable fruit number per plant (68.1), while the line SM 253B produced the minimum number of fruits 10.2 but the line SM253B produced the heaviest fruit (156.6 g). The line SM221B produced significantly the higher yield (62.0 t/ha) followed by SM048 (39.6 t/ha) and SM083A (36.1 t/ha), while the lowest yield (20.8 t/ha) was recorded from SM 229. Minimum infestation by eggplant fruit and shoot borer was observed in SM221B (10.5%) followed by SM229 (12.5%), SM012 (13.6%). Two types of fruit shape were observed viz., oblong (6 germplasm) and oval (4 germplasm/ variety), while three types of colour orientation within the green colour were observed among the germplasm viz., light green (5 germplasm), light green + white stripe (2 germplasm) and deep green + white stripe (3 germplasm). The results of the present study revealed that the line SM221B, SM 262, SM 083A, SM 048 and SM 012 was found promising for earliness, high yield and pest resistance and may be recommended for AYT.

Preliminary yield trial of purple coloured eggplant lines in winter

The study was conducted with 11 purple coloured eggplant lines/ variety at the experimental field of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during 2014-15 to select suitable lines for releasing as open pollinated variety of purple coloured eggplant. The lines varied significantly for their response to all characters. Line SM260 required minimum days to 50% plant flowering and days to first harvest which was 63.33 days and 90.4 days, respectively. Maximum marketable fruit number was obtained by SM236A (38.97), which was followed by SM260 (29.27), SM84B (26.87). Heavy sized fruit was harvested by SM254 (160.3 g) followed by SM210B (125.3 g). The yield range of eggplant lines was 19.80-52.10 t/ha, while the highest fruit yield (52.10 t/ha) was recorded from the line SM236A which was followed by SM254 (39.37 t/ha), SM210B (32.80 t/ha).The range of fruit infestation by BFSB was 4.83-22.23 %, while minimum infestation was in SM267. Five types of fruit shape was observed among the lines viz., elongate (4 lines), oval (1 line), oblong (2 lines), cylindrical (3 lines/ variety) and round (1 line), while two types of fruit colour was observed among the lines viz., purple (9 lines) and black purple (2 lines). Considering the yield contributing parameters studied four lines SM236A, SM254, SM210B and SM257 were found promising and may be recommended for AYT.

Advanced yield trial of green fruited eggplant lines

A study on the performance of nine eggplant lines with one variety BARI Begun 6 (check) was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 20014-15. The line SM011 took minimum days (90 days) to first harvest,while the most delayed harvested line was SM191B (112 days). The line SM021produced the longest fruit (17.07cm) which was identical to SM204B (16.93cm) and SM011 produced the shortest fruit (7.16 cm). The line SM011 produced maximum marketable fruit number per plant (59.27) while the lowest identical fruit number was produced by SM011, SM021, SM083B, SM191B, SM204A, SM204B and BARI Begun 6 which range was (14.9-18.57). The heaviest fruit was obtained from SM220 (3.46g) which was identical to SM221B (3.33g), whereas the lightest fruits was observed in SM 011 (2.46 g) and SM204B (2.50g).The line SM220 produced significantly higher yield (46.27t/ha) which was identical to SM220 (44.17t/ha), while lower production range was (32.73-37.00g) by SM011, SM021, SMO83B, SM191B, SM204A, SM204B. Minimum infestation by eggplant fruit and shoot borer was observed in SM083B (9.6%) while the highest infestation was recorded in SM204A (23.97). Three types of fruit shape were observed viz., oblong (4 germplasm), elongate (5 germplasm), oval (1 germplasm), while three types of colour orientation within the green colour were observed among the germplasm viz., light green (4 germplasm), Deep green + white stripe (5 germplasm), light green + white stripe (1 germplasm). The results of the present study revealed that considering earliness, high yield and other horticultural traits, the green fruited lines SM220, SM221B, SM223 and SM021 were found promising.

Advanced yield trial of purple fruited eggplant lines

A study on the performance of fifteen eggplant lines/ variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 2014-15 to study the performance of the selected purple fruited eggplant lines as well as to develop new purple coloured OP/ F_1 varieties. The line SM084B took minimum 75 days to first harvest. The line SM200 produced the longest fruit (28.4 cm), while SM083Eproduced the shortest diameter fruit (8.5 cm). The line SM084B produced the maximum marketable fruit number per plant (42), while the SM083E produced the heaviest fruit (180g). The line SM058C produced significantly the highest yield (50.94 t/ha) closely followed by SM083E (46.85 t/ha), SM083C (45.09 t/ha), SM181 (44.37 t/ha), SM063C (41.90 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in SM058C (10.5%) followed by SM083C (10.7%). Four types of fruit shape were observed viz., oblong (7 genotypes), long (6 genotypes), oval (1 genotype) and one round genotype. While four types of colour within the purple colour were observed among the germplasm viz., purple (8 genotypes), deep purple (3 genotypes), blackish purple (3 genotypes) and one magenta purple genotype. The results of the present study revealed that the lines SM058C, SM083C, SM083E, SM181, SM191A and SM063C were found promising for earliness, high yield and pest resistance.

Preliminary yield trial of summer eggplant lines

A study on the performance of five selected summer eggplant lines with check (BARI Begun 8) was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during the summer season of 2014 to evaluate the performances of selected summer eggplant lines. The lines SM058B and SM235 took the minimum days to 50% plant flowering and days to first harvest (61 days and 85 days). The line SM2058 B produced the maximum fruit number/ plant (38.47) followed by SM235 (29.67). The highest fruit yield (36.23 t/ha) was recorded from the line SM058B which was followed by SM021 (32.33t/ha). The range of fruit infestation by BFSB was (14.83 - 18.63%), while minimum infestation was in SM267 (14.83%). Three types of fruit shape was observed among the lines viz., oblong (4 lines), oval (1 line) and cylindrical (1 variety), while three types of fruit colour was observed among the lines viz., deep green+ white spot (2 lines), deep purple (2 lines) and purple (2 lines). The results of the present study revealed that the lines SM021, SM058B and SM235 were found promising and may be recommended for AYT.

Advanced yield trial of summer eggplant lines

A study on the performance of nine selected summer eggplant lines with check (BARI Begun 8) was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the summer season of 2014 to evaluate the performances of selected summer eggplant lines. The lines SM255 took the minimum days to 50% plant flowering and days to first harvest (53.67 days and 79.33 days, respectively). The highest marketable fruit number per plant was counted in SM011 (63.33) followed by SM236 (35.20) while the lowest from SM 274 (18.57).The highest fruit yield (36.43 t/ha) was recorded from the line SM011 which was close to SM262 (34.30 t/ha) and SM255 (33.20t/ha). The range of fruit infestation by BFSB was (13.70 – 20.67%), while minimum infestation was in SM011 (13.70%) which was close to SM236 (13.67%). Four types of fruit shape was observed among the lines viz., oval (2 lines), round (3 lines), elongate (2 lines) and cylindrical (3 lines/ variety), while five types of fruit colour was observed among the lines viz., Light green (2 lines), purple (4 lines), deep purple (2 lines), deep green+ white spot (1 line), light green+ white stripe (1 line). The results of the present study revealed that the lines SM011, SM262, SM255, SM254, and SM236 were found promising and may be recommended for RYT.

Preliminary yield trial of eggplant hybrids for winter

An experiment of eight F_1's of eggplant with BARI Hybrid Begun 3 (check) was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2014-15 to evaluate the performance of these hybrids regarding yield and pest resistance. The hybrid $F_1$19x4and $F_1$3x203 took minimum days to 50% flowering and days to 1st harvest. $F_1$19x4produced the longest fruit (28.0 cm) followed by hybrid $F_1$1x14 (25.0 cm), and $F_1$21x13 produced the maximum diameter fruit (7.5 cm). Hybrid $F_1$1x14 produced the highest marketable fruit number per plant (40.37) where the $F_1$3x203 produced the heaviest fruit (170.3 g). The highest fruit yield per plant (4.20kg) was recorded from $F_1$14x203 which was identical with F_1 3x203 (4.13kg) The $F_1$14x203gave significantly higher yield (55.85 t/ha) followed by $F_1$3x203 (55.31 t/ha), $F_1$14x5 (51.68 t/ha) and $F_1$20x203 (52.0 t/ha). Minimum infestation by eggplant fruit and shoot borer (14.03%) was observed in BARI Hybrid Begun 3, where the infestation range was 14.03-22.30%.The results of the present study revealed that the hybrids $F_1$3x203, $F_1$14x5, $F_1$14x203, $F_1$20x203 and $F_1$21x13 were found promising and may be recommended for AYT.

Advanced yield trial of hybrid eggplant lines for summer season

A study on the performance of nine selected summer eggplant hybrid lines was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during the summer season of 2014 to evaluate the performances of those selected summer eggplant hybrid lines. The hybrid line was F_1 5x11 took the minimum days to 50% plant flowering and days to first harvest (59.33 days and 85.33 days, respectively). The line $F_1$19x14 produced the maximum fruit number/ plant (56.0) followed by F_1 3x9 (48.00). The highest fruit yield (50.77 t/ha) was recorded from the line $F_1$14x5 which was followed by F_1 20x5 (43.39 t/ha), F_1 5x11 (40.23 t/ha). The range of fruit infestation by BFSB was (17.40 - 25.67 %), while minimum infestation was in F_1 5x11which was followed by $F_1$1x19, F_1 3x9 (18.33 %). The results of the present study revealed that the hybrid lines $F_1$14x5, F_1 20x5, F_1 5x11 were found promising and may be recommended for RYT in next summer season.

Advanced yield trial of eggplant hybrids for winter season

An evaluation of eight F_1's lines/varieties was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2014-15 to evaluate the performance of these hybrids regarding yield and pest resistance. In respect of days to 50%

flowering the earliest line was F_1 13x229 (61.33 days) while the delayed line was BARI Hybrid Begun 2 (82.67 days). The hybrid 13x229 took the minimum days to 1st harvest (92.67 days) while BARI Hybrid Begun 2 took maximum days (112.3 days). The highest marketable fruit number per plant (42.37) was recorded from BARI Hybrid Begun 3 followed by $F_1$3x9 (35.67), F_1 13x229 (36.0), while BARI Hybrid Begun 2 produced the lowest number of marketable fruit per plant (16.20). BARI Hybrid Begun 4 produced the longest fruit (23.33 cm) followed by $F_1$3x9 (21.33cm), F_1 20x5 (22.0 cm), while shortest fruit was obtained by BARI Hybrid Begun 3 (10.67cm). Maximum diameter fruit was produced by $F_1$13x12 (8.47 cm) followed by F_1 5x11 (6.07 cm), F_1 13x229 (5.70 cm), F120x5 (6.03 cm), BARI Hybrid Begun 2 (5.70 cm) while minimum was obtained by BARI Hybrid Begun 4 (3.17 cm). The heaviest fruit weight was (4.40 kg) was harvested from F_1 13x229, while the lowest was obtained from BARI Hybrid Begun 2 (2.73 kg). Significantly the highest yield was produced by BARI Hybrid Begun 3 (48.63 t/ha) followed by $F_1$3x9 (39.23 t/ha), $F_1$13x229 (39.60 t/ha) and F_1 5x11 (31.57 t/ha), while the least at per were in $F_1$13 x12 (19.07 t/ha) and BARI Hybrid Begun 2 (20.03t/ha). Minimum infestation was in BARI Begun 4 (12.17) by fruit and shoot borer was observed in F_1 19x14. The results of the present study revealed that the hybrids $F_1$13x229, $F_1$3x9 and $F_1$5x11 were found promising for earliness, high yield and pest resistance and may be recommended for RYT.

Regional yield trial of eggplant hybrids

A study on the regional yield performance of eggplant hybrid lines was conducted at geographically distinct 3 locations viz., Joydebpur, Jessore, Ishurdi of Bangladesh Agricultural Research Institute, during the winter season of 2014-15. Three eggplant lines viz., $F_1$1x5, $F_1$1x19, $F_1$14x5 and BARI Hybrid begun 2 (as check) were included in the study. The Average highest marketable fruit number per plant (16.80) was produced by F_1 14x5, while maximum fruit yield (29.20t/ha) was also produced by F_1 14x5 followed by F1 1x5 (25.76 t/ha). The results of the present study revealed that the F_1 14x5 and F_1 1x5 were found promising. So it may be recommended that the hybrid line F_1 14x5 may be released as a new hybrid variety or after another one evaluation in the next year.

Tomato

Varietal improvement

Evaluation of tomato lines at early and late winter

The experiment was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, BARI during 2014-2015 with five tomato varieties and four lines to evaluate their performance at early and late winter. In early planting, all the varieties and lines showed identical in days to 50% flowering but in late planting, the line C-51 showed earliness. In respect of harvest duration no significant difference was shown in both the time. In early planting, BARI Tomato14 produced the tallest plant (83.10cm) which was identical to C-11 (83.07cm) and in late winter, the line C 51 produced the tallest plant (64.33Cm) while BARI Tomato 3 (52.17cm) and BARI Tomato 2 (33.93cm) produced the shortest plant. The line C- 51 (18.33) and C-11 (29.3) produced the highest number of fruit in early and late winter respectively, while the line WP-7 produced the highest identical yield (18.77 and 29.7) in both the time. Minimum numbers of fruits (11.70 and 13.80) were produced from BARI Hybrid Tomato 3 and BARI Tomato 2 in early and late winter respectively. BARI Hybrid Tomato 8 produced the heaviest fruit (82.20 g) which was identical with BARI Tomato 14 (77.0 g) in early winter and in late winter BARI Tomato 15 produced the heaviest fruit (47.0 g). Fruit length and breadth were significantly varied in both the time and ranged were 3.43- 6.30 cm and 3.83-6.10 cm in early winter and 3.10- 6.13 cm and 3.53-6.36 cm in late winter, respectively. The highest fruit yield per plant was recorded from WP- 7 (1.21kg), followed by BARI Hybrid Tomato 8 (1.08 kg) in early winter but in late winter BARI Tomato 15 (1.12kg), followed by BARI Hybrid Tomato 8 (0.94kg) showed the highest per plant fruit yield, the lowest yield (0.55kg and 0.54kg) was recorded from C11 and C71 in both the time. Calculated the highest per hectare yield were recorded from WP-7 (41.20t/ha) followed by BARI Hybrid Tomato 8 (36.97t/ha), in early winter and BARI Tomato15 (37.98t) followed by BARI Hybrid Tomato 8 (31.94t) and C-11(31.27t) were recorded in late winter. The lowest yield (18.87t/ha and 18.30t/ha) were recorded from C11 and BARI Tomato 2 in early and late winter. Total soluble solid (TSS %) ranges were 3.1-5.1 and 3.00-5.30 were observed in early and late winter respectively. So, it may be recommended that for bigger size and yield potentiality, BARI Hybrid Tomato 8 is suitable for both the time. Besides this, the line WP-7 is suitable for early planting for good number of fruit and higher yield and BARI Tomato15 is suitable for late planting for bigger size fruit and higher yield.

Advanced yield trial of multiple disease tolerant AVRDC tomato lines

The study was conducted at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2014-15 to evaluate selected multiple disease tolerant AVRDC tomato lines. Significant variation was observed among the lines in respect of different characters studied. A wide range of variation in number of fruits per plant was observed which varied from 28.30 to 38.50 and average fruit weight also varied from 67.00 to 96.0g. Maximum fruit yield per plant and per hectare obtained from the line AVTO1229 (3.51 kg/plant; 105.10t/ha) followed by AVTO1316 (3.48kg/plant; 103.62t/ha) and AVTO1317 (3.02kg/plant; 98.55t/ha). There was no virus and late blight infection in all the lines except BARI Tomato 14 and BART Tomato 15. The line AVTO11218, AVTO1228, AVT01229, AVTO1316 and AVTO1317 were showed virus tolerant and also higher yielder. These lines may be recommended for multi-location trial for confirmation of the results.

Adaptive trial of SVATNet tomato lines

The experiment was conducted at the experimental field of Olericulture Division, Horticulture Research Centre, BARI, Gazipur during the winter season of 2014-15 to evaluate SVATNet tomato lines. There was significant variation among the lines in respect of different characters studied. A wide range of variation in number of fruits per plant was observed which varied from 25.34 to 45.01, while the average fruit weight also varied from 65.34 to 91.40g. Fruit yield per plant varied significantly and it ranged from 2.11kg/plant to 3.51kg/plant. There was significant variation in fruit yield per hectare; highest fruit yield was found from STM006 (91.91 t/ha) and followed by STM008 (88.79t/ha) and minimum fruit yield was found from BARI tomato 15 (66.90t/ha). On the basis of yield and yield contributing characters, virus infection, two lines viz STM006 and STM008 were selected as promising and may be selected for further evaluation.

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

An experiment was conducted to study the preliminary trial of tomato inbred lines for yield, diseases resistance and shelf life with eight 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 2014-15. The AVRDC supplied eight lines tomato lines viz.: AVTO9708 (Tanya), AVTO9331 (UC204A), AVTO1420 (CLN3670B), AVTO1418 (CLN3669A), AVTO1424 (CLN3682C), AVTO1289 (CLN3552C), AVTO1288 (CLN3552B) and AVTO1455 (CLN3125L-5X65) along with one local check (GPT0017) were 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 43-50 days. It may be due to the genetic potentiality as the lines are inbreeds. In respect of fruit number per plant varied from 32 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 AVT09708 (32). In the case of average fruit weight, the largest fruit was harvested from AVTO1288 (91.67g) followed by AVT01289 (87.66g) and the smallest average fruit weight were obtained from AVT01418 (62.00g).

The length and diameter of fruits of different lines also varied significantly. The marketable fruit yield per plant varied from 1.77 to 2.66kg. The highest marketable fruit yield per hector was obtained from control (66.94 tons) while second highest yield (65.50 tons) was exhibited by AVT01455, AVTO1288 and AVTO1420. The line AVTO9708 and AVTO9331 were severely and slightly TYLCVD affected respectively. In respect of postharvest attributes, the lines AVT01420, AVT01289, AVTO1288, AVTO1455 and control showed satisfactory magnitude lightness, hue angle, TSS, firmness, dry matter percentage, P^H and vitamin-C for fresh product. The same lines 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, four entries like AVTO1459, AVTO1463, AVTO1438 and AVTO1468 found to be better compared to other entries. Therefore, theses lines may be selected for putting into advanced yield trial in the following year to confirm the results.

Regional yield trial of selected beta carotene rich tomato lines

Regional yield trial (RYT) were conducted at different locations (Six ARS and RARS) at six locations of BARI which include Joydebpur, Jamalpur, Akberpur, Ishurdi, Hathazari and Potuakhali in the winter season of 2014-15 to evaluate the performance of selected beta-carotene rich tomato lines. Selected three beta-carotene rich tomato lines viz.: GBT037, GBT053 and GBT056 were selected for this study with BARI Tomato 7 was considered as check. The lines were similar for their response to marketable fruits per plant (MF/Pl), and marketable yield per hectare (MY/ha) when data of different locations was combined. All the lines had closer MF/Pl (25.78 – 26.67) as the check variety (26.46) at combined data. GBT037 produced very closer yield (88.10 t/ha) compare to check variety (87.87 t/ha) but other line GBT053 was lower (82.04) at combined data. The lowest degree of virus infection was observed in GBT037 (4.16%), while the highest (8.33%) virus infection was recorded from the tomato line GBT056. The line GBT037 and GBT 056 exhibited the highest mean yield (88.10 t/ha) over locations with good adaptability. Therefore, the experiment may be repeated to confirm the results.

Regional yield trial of advanced lines of tomato in winter

The study consisting of four lines of tomato and BARI Tomato 14 as a check variety was conducted at four locations of BARI which include Joydebpur, Jamalpur, Akberpur and Potuakhali in the winter season of 2014-15. All the lines had higher marketable fruits per plant (42-47) than the check variety (41) at combined data. All the lines produced higher yield (72.82 – 80.99 t/ha) than the check variety (72.43 t/ha) at combined data. Line AVTOV 1010 was maximum yielder (80.99 t/ha) at combined data. No virus incidence was observed in any of the liens (0.0%) while the check variety 15% incidence at Joydebpur location under field condition. Among the lines, AVTOV1005 and 1010 showed better performance for resistance to bacterial wilt, TYLCV, fusarium wilt, tobacco mosaic virus under inoculated condition at AVRDC. These were also good for lycopene content, fruit shape and growth habit. Therefore, necessary steps can be taken for releasing these two lines as OP varieties.

Regional yield trial of tomato lines for processing

The experiment was conducted with four processing tomato lines of AVRDC with check BARI Tomato-3 at four locations of BARI which included Joydebpur, Hathazari, Jamalpur and Burirhat during the season 2014-2015 to evaluate the performance processing tomato lines to develop new processing tomato variety for Bangladesh. On an average of four locations, fruit number per plant were varied from 36 (control) to 58 (GPT017) while the highest number of fruits (64) were counted from the line GPT017 at Burirhat and the lowest (30) number of fruits beard in control at Hathazari. In respect of fruit yield, the highest average yield (65.17) was recorded from the line GPT017 and the lowest fruit yield (54.77) was obtained from the line GPT015. Fruit yield over location indicated that the highest yield (73.33) contributed by the line GPT017 at Burirhat. The experiment having all the

GPT lines may be repeated as regional yield trial (RYT) to confirm the yield potentiality and adaptability in different agro-ecological zones of Bangladesh.

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

A regional yield trial of four selected Ty gene inserted tomato lines of AVRDC with check BARI Tomato 15 at four location of BARI which included Joydebpur, Jamalpur, Hathazari and Burirhat in the winter season of 2014-15 to evaluate the performance of selected tomato lines at different AEZ. Average fruit number, fruit yield per hectare over locations and postharvest parameters in relation to qualitative characters conducted at Joydebpur are discussed. On an average of three locations, fruit number per plant were varied from 45 (SL008) to 55 (control) while the highest number of fruits (58) were counted from the control at Joydebpur and the lowest (37) number of fruits beard in SL0010 at Hathazari. In respect of fruit yield, the highest average yield (70.10 t/ha) was recorded from the line SL008 and the lowest fruit yield (59.21 t/ha) was obtained from the line SL0001. Fruit yield over location indicated that the highest yield (82.96 t/ha) contributed by the line SL008 at Joydebpur. The experiment having all the Ty gene inserted lines may be repeated as regional yield trial (RYT) to confirm the yield potentiality and adaptability in different agro-ecological zones of Bangladesh.

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

The experiment was conducted with two selected cherry tomato lines of AVRDC and one advance cherry tomato line with check BARI Tomato 11 at three locations of BARI which included Joydebpur, Hathazari, and Jamalpur during the season 2014-2015 to evaluate the yield performance of cherry tomato varieties for Bangladesh. Average fruit number, fruit yield per hectare over locations and postharvest parameters in relation to qualitative characters conducted at Joydebpur are discussed. On an average of three locations, fruit number per plant were varied from 167 (SL0011) to 222 (control) while the highest number of fruits (256) were counted from the control at Joydebpur and the lowest (142) number of fruits beard in SL0011 at Hathazari. In respect of fruit yield, the highest average yield (62.13 t/ha) was recorded from the line SL0012 and the lowest fruit yield (51.66 t/ha) was obtained from the line SL0067. Fruit yield over location indicated that the highest yield (82.96 t/ha) contributed by the line SL0012 at Joydebpur. The experiment having all the cherry lines may be repeated as regional yield trial (RYT) to confirm the yield potentiality and adaptability in different agro-ecological zones of Bangladesh.

Regional yield trial of selected semi-determinate tomato lines

A regional yield trial of two selected semi-indeterminate type tomato lines with BARI Tomato 14 as check was conducted at four location of BARI which Joydebpur, Jamalpur, Hathazari and Burirhat in the winter season of 2014-15 to evaluate the performance of selected semi-determinate tomato lines at different AEZs. Mean fruit numbers per plant were varied from 37 (GWT 052) to 45 (GWT043) over different locations, while the highest number of fruits per plant (55) counted at Joydebpur in GET043 and the lowest number of fruit (25) were exhibited from the line GWT052 at Hathazari. In respect of fruit yield per hectare over locations revealed that 63.24t (GWT052) to 72.02t (BARI Tomato 14) were obtained while second highest yield (70.29t) was recorded from the line GWT043 which is statistically similar with control. The magnitude of virus infection indicted that all the lines along with control were virus infected which was confined to 10%. The experiment may be repeated as regional yield trial to confirm the results to assess the adaptability and yield potentiality at different agro ecological zones of Bangladesh.

Preliminary 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 2014-15 to study the yield performance and shelf along with pest and diseases reaction. The AVRDC supplied nine hybrid tomato lines viz.: AVTO1432 (CLN3940), AVTO1459 ((CLN3946), AVTO1437 (CLN3947), AVTO1463 (CLN3948), AVTO1438 (CLN3949), AVTO1461 (CLN3953), AVTO1468 (CLN3954), AVTO1465 (CLN3961) and AVTO9708 (Tanya) along with one local check (BARI Tomato 14) were included in this study. The tomato lines differed significantly in most of the parameters studied. The findings of major parameters revealed that: days to 50% flowering was observed uniform and earlier than control that was confined in 44-50 days. It may be due to the genetic potentiality as the lines were hybrid lines. In respect of fruit number per plant varied from 30 to 56, while the highest number of fruit (56) was counted in the line AVTO1463 as because it was genetically good fruit bearer type and the lowest number of fruits was counted in AVT09708 (30). In the case of average fruit weight, the largest fruit was harvested from BARI Tomato 14 (98.98g) followed by AVT01463 (94g) and the smallest average fruit weight were obtained from AVT01432 (66.93g). The length and diameter of fruits of different lines also varied significantly. The marketable fruit yield per plant varied from 1.92 to 3.35 kg while the lines AVT01459, AVT01463, AVT01438, AVT01468 and control contributed statistically identical fruit yield. The highest marketable fruit yield per hector was obtained from AVT01463 (84.30 tons) while second highest yield (81.37 tons) was exhibited by AVT01459. In respect of postharvest attributes, the lines AVT01459, AVT01463, AVT01438 and AVT01468 showed good shelf life that was confined to 18 to 20 days that was 70% more days over control. Satisfactory magnitude of Vit.-C content and firmness of fruits were also exhibited from the same lines and that was 18.0-19.5µg and 1.82-2.17kg-F respectively. Virus and wilt resistance was also shown in the same lines except one line (AVTO9708) and control. Considering the growth habit, diseases infection rating, shelf life, qualitative traits and yield, four entries like AVTO1459, AVTO1463, AVTO1438 and AVTO1468 found to be better compared to other entries. Therefore, theses lines may be selected for putting into advanced yield trial in the following year to confirm the results.

Preliminary yield trial of selected F_1 tomato lines

A study on performance of ten selected hybrids tomato lines with BARI Hybrid Tomato-9 used as check was conducted at the experimental field of Olericulture Division of HRC, BARI during winter season of 2014-15. The treatment P_2 x P_6 produced maximum number (69) of fruits per plant. The highest yield per plant was recorded from P_4 x P_9 (4.23kg) followed by 4.02 kg harvested from P_5 x P_9. Maximum yield per ha was obtained from P_4 xP_9 (78.94t) followed 77.98t contributed by the new hybrid line P_5 x P_9. Considering the desirable horticultural traits, P_1 x P_5, P_2 x P_9, P_4 x P_9, P_5 x P_8 and P_5 x P_9 hybrid may be selected for regional yield trial in the next year to confirm the results at different agro ecological zones of Bangladesh.

Studies on the combining ability and heterosis in tomato

A study on combining ability and heterosis of nine parents and their 45 crosses (half diallel) was conducted at the experimented field of Olericulture Division of HRC, BARI during winter season of 2014-15 to evaluate the combing ability and heterosis performance of the selected hybrids. The GCA and SCA effects of parents and their crosses and percent heterosis over better and mid parent were recorded. The parent $P_{1,}$ P_5 and P_6 exhibited the highest positive GCA effects for fruit yield per plant. The parents $P_{4,}$ P_5 and P_6 were found as the good combiner for producing highest number of seed per fruit. There was positive SCA in respect of number of fruits per plant from the cross combinations of P_1 x $P_{3,}$ P_{1x} $P_{6,}$ P_1 x $P_{7,}$ P_1 x $P_{9,}$ P_2 x $P_{8,}$ P_3 x P_6 and P_6 x $P_{8.}$ The best crosses with the highest estimates of SCA effects for fruit yield/plant were P_1 x $P_{6,}$ P_1 x $P_{7,}$ P_3 x $P_{5,}$ P_5 x P_9 and P_7 x $P_{9.}$ There were 11 crosses showed positive heterosis in number of fruits per plant. Among these 11 crosses seven crosses showed above 15% heterosis even it was up to 70%. Positive heterobeltosis in fruit yield per plant revealed in six crosses and it was ranged from 7.48 to 75.44 % over better parent. The highest heterosis was obtained in cross P_1X P_7 (75.44%) while the lowest heterosis recorded in the cross P_1X P_5 (7.48%). In respect of number of seeds per fruit also showed significant positive heterosis in six crosses which was ranged from 5.13 to 25.69%. Considering, earliness, fruit size & shape, color, quality, TSS, number of seeds per fruit, level of virus tolerance and fruit yield per plant, P_1 x P_3, P_1 x P_6, P_1 x P_7, P_3 x P_6, P_6 x P_8, P_3 x P_5, P_5 x P_9 and P_7 x P_9 hybrids were selected for performance study in the following year.

Development of inbred tomato lines through segregating population

Nine winter tomato F_4 populations were evaluated at the experimental farm of HRC, BARI during winter season of the year 2014-15 to select desirable segregants from segregating F_3 population. Among the tested lines, five lines (single plant selection) were selected and among these selected plants segregants GWT 102-3-1-2-8 gave the highest yield (4.35kg) and closely followed by the second highest yield 4.10kg and 4.01were exhibited by the individual segregants GWT 102-3-3-11-7 and GWT 102-2-1-12-5 respectively and five segregants have been selected for further evaluation in following year.

Heterosis in summer tomato

The study was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in the summer season of 2014. Fourteen hybrids of summer tomato and their parents were included in this study to estimate heterosis relative to mid parent and heterobeltiosis, and select better hybrids. Both positive and negative heterosis was observed for different quantitative and qualitative characters of summer tomato. Four hybrids S12Hybrid-42, 43, 44 and 47 out of 14 exhibited significant positive heterosis relative to mid parent for marketable fruits per plant (MFT/pl) (77.1^{*}, 90.5^{*}, 166.8^{**} and 140.9^{**} % respectively), marketable yield per plant (MY/pl) (77.4^{*}, 99.4^{*}, $134.7^{**}$and 105.3^{*}% respectively) and marketable yield per hectare (MY/ha) (75^{*}, 97^{*}, $130^{**}$and 100.3^{*}%, respectively). Similarly S12Hybrid 43 showed significant positive heterobeltiosis for MFt/pl (60.6* %), MY/pl (71.8*%) and MY/ha (72.2*%) while two hybrids S12Hybrid 44 and 47 exhibited outstanding significant positive heterobeltiosis for fruits per cluster (Ft/cl) (34.6* and 51.9**%, respectively), MFt/pl (157.5** and 91.5**% respectively), MY/pl (106.8** and 96.7*% respectively) and MY/ ha (106.9** and 96.9*%, respectively). Based on the characters studied for mid parent heterosis and heterobeltiosis, visual looking of fruit and plant health at least three hybrids S12Hybrid 43, 44 and 47 were found promising for utilizing in the summer hybrid tomato variety development program in future.

Regional yield trial of hybrids of tomato in summer

The study consisting of three hybrids and BARI Hybrid Tomato 4 as a check was conducted at three locations of BARI which include Joydebpur, Potuakhali and Akbarpur in the summer season of 2014-15. All the hybrids produced lower MF/Pl (19) than the check variety (22) when data of different locations was combined. It ranged from 14-27 across the locations. Av Fruit weight was much higher in all the hybrids (47.11-48.23g) except WS11 Hybrid 14 (38.60g) than the check variety (40.35g) at combined data. Two hybrids WS11Hybrid 2 and 3 produced higher yield (34.22-35.87t/ha) than the other hybrid (26.36t/ha) and check variety (32.52t/ha) at combined data. Among the hybrids, hybrid WS11Hybrid 3 produced maximum yield (35.87t/ha). Virus incidence was lower in all the hybrids (6.1-7.95%) than the check variety (22.08%). Incidence of bacterial wilt was 0.0% in all the test hybrids and the check variety. Considering all the parameters studied two hybrids, WS11 Hybrid 2 and 3 were found promising as summer variety which can be processed for release.

Regional yield trial of selected summer tomato hybrids

Three selected summer hybrids along with BARI Hybrid Tomato 4 and BARI Hybrid Tomato 8 were tested at Olericulture Division, HRC, BARI, Gazipur during the summer season of 2014 with a view to develop summer hybrid tomato variety(s). The hybrid CLN 3150-A-5 x 3125-0-19 had the highest individual fruit weight (86.1 g). The variety BARI Hybrid Tomato-4 produced the highest number of fruits per plant (30.4). The selected hybrid produced around 25- 28 fruits per plant. The highest fruit yield was recorded (2. 35 kg/ plant) in the CLN 3324A xCLN3241AA which was closely followed by the hybrid CLN 3150-A-5 x 3125-0-19 (2.20 kg/plant). The virus infection recorded at 30-45 days after planting around 10% in the selected hybrid where as more than 50 percent plants infected in BARI Hybrid Tomato 4. After assessing the results of all location one/two hybrids might be selected for releasing new variety/s

Regional yield trial of hybrids tomato for winter

The study with four hybrids and BARI Hybrid Tomato 5 as a check variety was conducted at five locations of BARI which include Joydebpur, Ishwardi, Jamalpur, Potuakhali and Akberpur in the winter season of 2014-15. The response of test hybrids to marketable fruits per plant (MF/Pl), average fruit weight (AvFtwt), and marketable yield per hectare (MY/ha) when data of all the locations were combined. Marketable fruits per plant varied from 30 (W11Hybrid 33) to 46 (WS11Hybrid 1) at combined data while it ranged from 20- 80 across the locations. The test hybrids WS11Hybrid 1 had higher marketable fruits per plant (45.49) than the check variety (37.54) at combined data. Average fruit weight was higher in three hybrids W11Hybrid 33, 35 and 37 (102.70- 111.92g) than the check variety (91.56g) at combined data. Except W11Hybrid 37 all the test hybrids produced higher and similar yield (97- 109 t/ha) than the check variety (92.27t/ha) at combined data. W11Hybrid 35 gave average higher yield (108.45 t/ha) at combined data. Three hybrids (Hybrid 1, 35 and 37) had lower virus incidence (0.0-5.7 %) than the check variety (7.2 %) of which Hybrid 1 may be considered as highly resistant (HR) (0.0 % incidence) while the rest resistant (R) (4.2-7.2 % incidence) under field condition. Considering average fruit weight, marketable fruits per plant, marketable yield per hectare and virus reaction two hybrids, hybrid 35 and 37 were found promising which can be processed for release as variety.

Possibilities of using side shoots as propagation materials in tomato production

A study was conducted at Horticultural Research Centre, BARI, Joydebpur during winter season 2014 to study the minimizing the seed cost on the purchase of hybrid seeds each time for a new crop and test the efficacy of IBA in the rooting of tomato side shoot cutting. The cuttings were dipped for 5 minutes in 50, 100, and 150 ppm solutions of Indole Butyric Acid (IBA), Fungicide solution (Dithem M 45 @ 2g /liter water) and control (Water) and statistically compared. The results showed that treatment with 150 ppm of 1BA was found more effective in enhancing the rooting effect and root length of tomato cutting compared 100 ppm, 50 ppm concentration of 1BA and fungicide 2g/ litter water. The highest root number per shoot cutting was obtained from IBA 150 ppm (69 roots) which gave about 60 % higher than the control. Yield per plant were not as much as that of 100 ppm of 1BA and fungicide treated cutting. This was the first year experiment; it may be repeated to confirm the results.

Effect of stem pruning on quality seed production of selected tomato varieties

A study was conducted at the experimental field of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year of 2014-15. Three types of pruning has been used namely one shoot pruning, two shoot pruning, three shoot pruning with normal pruning as a check. The maximum seed yield per hectare was obtained from the treatment T_1 S_1 (60.23kg/ha) followed by T_3S_1 (56.78 kg/ha), T_2S_1 (55.06kg/ha), T_4S_1 (47.33kg/ha) and T_3 S_2 (42.45kg/ha).Lowest seed yield obtained from T_1S_2. In case of seed viability, the highest viability obtained from T_2S_1 (99%) and T_4S_1 (99%).

Capsicum

Varietal improvement

Advanced yield trial of AVRDC capsicum lines

The experiment was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur with five capsicum lines collected from world vegetable centre of the Asian Vegetable Research and Development Center (AVRDC), Taiwan and BARI Mistimorich 1 as check during the winter season of 2014-2015 to evaluate the selected capsicum lines collected from AVRDC to search a new variety and their adoptability. From this trial it was found that most of the genotypes showed good performance in respect of yield and yield contributing characters. Earlier flowering was recorded from the line ISPN 11-2 (39.67 days), which was identical to the check variety BARI Mistimorich 1(39.71 days). The highest number of fruits per plant was recorded from the line ISPN 11-4 (9.30). The highest average fruit weight was found in the line ISPN 11-3 (140.4g). The line ISPN 11-1 was the highest fruit yielder (38.51 t/ha) among the evaluated lines, which was followed by the line ISPN 11-3 (31.17/ha). The lowest yield was obtained by the line ISPN 11-2 (19.76t/ha). But all the genotypes were found excellent for their yield, color, shape and size of fruits. The line ISPN 11-1 exposed light green colour, ISPN 11-2, ISPN 11-3 and ISPN 11-4, remained light green to green colour, whereas AVPP 1202 and BARI Mistimorich 1 were deep green coloured fruit at their edible stage. But all the genotypes showed different attractive colour at their matured stage. Red colour was obtained from the line ISPN 11-1, ISPN 11-2 and ISPN 11-4. Yellow color was noticed from two lines, ISPN 11-3 and AVPP 1202. Fruit shapes were also different with their peduncle attachment. It was observed that tunnel cover with nylon net with polythene is required for growing capsicum during winter.

Regional yield trial of coloured capsicum lines

The experiment was carried out at four different locations across the country, which included Joydebpur, Jamalpur, Narsingdi and Comilla during October 2014, April 2015. Four lines/varieties of some coloured capsicum collected from different sources were included in the study. The average number of fruits/plant ranged from as low as 7.26 in ISPN 9-5 to as high as 8.44 in CA 0024. The highest average fruit weight was also obtained from the advanced line CA 0024 (113.55g). Except Narsingdi this line showed best performance in other three locations in this regard. The highest average yield (t/ha) was obtained from the advanced line CA 0024 (30.52 t/ha). The lowest yield came from ISPN 9-5 which was 18.76 t/ha. Considering yield performance of the lines from four locations, it was evident that all the three lines performed better. After four years completion of RYT in different locations, the advanced line CA 0024 has already been proposed as the first yellow coloured OP capsicum variety namely BARI Mistimorich 2.The other studied three lines may be recommended for further evaluation with some other management practices.

Studies of the heterosis in capsicum

The experiment was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur during the winter of 2014-2015. The average fruit weight ranged from 55.88 to 116.60g and the heaviest fruit was yielded by $P_1{\times}P_4$ (116.60 g) followed by $P_3{\times}P_4$ (111.31g) and $P_1{\times}P_2$ (110.30g). Number of fruits per plant revealed that highest number of fruit per plant was found from $P_4{\times}P_5$ (9.31) and lowest from $P_2{\times}P_4$ (4.54). The highest fruit yield was recorded in the cross $P_1{\times}P_2$ (1009.24 g) followed by $P_1{\times}P_4$ (967.78g) and $P_3{\times}P_4$ (965.05g). Among the cross combination the crosses P_1xP_2 (32.29 t/ha), $P_1{\times}P_4$ (30.96 t/ha), P_3xP_4 (30.08 t/ha) and $P_4{\times}P_5$ (30.78 t/ha) showed high fruit yielder and also significant positive better parent heterosis in respect of yield. Considering the yield and heterotic performance, the crosses, P_1xP_2, $P_1{\times}P_4$ and $P_3{\times}P_4$, $P_4{\times}P_5$ may be selected for further evaluation.

Advanced yield trial of capsicum hybrids

This study of seven F_1's of capsicum was conducted at the farm of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2014-15. The hybrid 4x5 took the minimum days to 1st harvest (55 days). The highest number of fruits per plant (9.64) was recorded from $F_1$3x5. The heaviest fruits (144.50g) were obtained from F_1 2x4. Fruit weight per plant was found maximum (1.15kg) in $F_1$3x5 followed by the $F_1$1x2 (1.10 kg), Fruit weight per plant was found maximum (1.15kg) in $F_1$3x5. The highest yield was produced by $F_1$3x5 (46.28 t/ha) followed by the $F_1$1x2 (43.92 t/ha). Minimum infestation by fruit borer (1.02%) was observed in $F_1$3x5, This hybrid line also performed well against white fly and mite infestation. All the studied lines were differed in various colors, which is varied from red to deep red, only one hybrid was found yellow color in matured stage. These three hybrids $F_1$3x5, $F_1$1x2 and $F_1$4x5 were found promising for earliness, high yield, color variation and insect pest reaction. So these three lines may be recommended for further AYT.

Effect of spacing and training on growth and yield of capsicum

An experiment with three spacing; 45 × 30 cm, 45 × 45 cm, 45 × 60 cm and three training level; 2 shoots, 3 shoots, 4 shoots per plant was carried out at HRC field, RARS, BARI, Jamalpur during the winter season of 2014-15 to find out the effect of spacing and training on the growth and yield of capsicum. Spacing of 45 × 45 cm in combination with 4 shoots per plant manifested maximum yield (23.09 t/ha). From the results, it may be concluded that, medium spacing (45 × 45 cm) combined with four shoots per plant resulted in higher growth and yield.

Cauliflower

Evaluation of cauliflower germplasm

The study was undertaken with nineteen collected germplasm from different sources (both local and exotic) and BARI released variety (BARI Fulcopi 1) at the experimental field of Olericulture Division, HRC, BARI, Gazipur during September 2014 to January 2015. Based on harvesting maturity and yield potentiality the lines/variety were categorized in two group's viz. early harvesting and late harvesting. In respect of days to 50% curd initiation earliness was found in BOB-010 (68 days) and the most delayed line was BOB-181 (78 days).Early lines BOB-010 took 78 days to harvest and the late line BOB-181 took 86 days to harvest. Harvest duration varied from 2-22 days. The line BOB-181 produced the longest curd (15.5 cm) while BOB-183 produced the smallest curd (6.0 cm). Maximum curd diameter was produced by the line BOB 013 (23.7 cm) while minimum curd was produced by BOB-181 (8.0 cm). The bigger only sized curd was obtained from the germplasm BOB-004 (960.0 g) which range was 300-960 g. The highest marketable curd yield 1200 g was recorded from the line BOB-004 and the lowest marketable curd weight was found in BOB-020 (450 g). Among the 20 lines/ variety, 6 lines viz., BOB-006, BOB-007, BOB-009, BOB-010, BOB-013 and BOB-183 were early harvesting type which required up to 80 days from sowing to first harvest and rest of the thirteen lines including BARI Fulcopi 1were late harvesting type and which required over 80 days. Considering harvesting duration, the lines were categorized into three groups viz., short duration (up to 7 days), medium duration (up to 14 days) and long duration (over 14 days). Ten lines produced higher marketable curd, ranging 787.5-1200 g. Six lines and BARI Fulcopi 1 (check variety) produced medium yield, ranging 540.0-700.0 g and the rest two lines produced lower yield ranging 450.0-500.0 g. Further trial will be conducted by adjusting planting time to find out the suitable planting time for each group to achieve maximum yield and the lines will be studied to verify their curd harvest duration indicating their market availability.

Regional yield trial of advanced early cauliflower lines

The experiment was conducted with two advanced cauliflower lines with one check variety (BARI Fulcopi 1and Maradona) at four locations of BARI which included Joydebpur, Hathazari, Jessore and Comilla during the season 2014-2015 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 (74.8 and 70.75days) and local check Maradona required 71 days to curd harvest while BARI Fulcopi-1 failed to curd production. Among the two advanced lines, CL-0172 produced heaviest marketable curd (352.3 g), while the line CL-0171 (288.5g) and Maradona produced (586.7g) marketable curd weight. The highest calculative per hectare yield (11.64 t) was recorded from the line CL-0172 and the line CL-0171produced (9.78t) while check variety Maradona produced (23.47t). Considering the earliness and yield the advanced line CL-0172 showed best performance and may be recommended as an early cauliflower OP variety at different agro-ecological zone of Bangladesh.

Effect of molybdenum and method of application on seed production of cauliflower

The experiment was conducted at Regional Agricultural Research Station, Ishwardi, Pabna during rabi season of 2014-15 to find out the appropriate dose of molybdenum for seed production of cauliflower (var. BARI Fulcopi 1). Five Mo doses viz. 0, 0.5, 1.0, 1.5 and 2.0 kgha^{-1}, 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^{-1} was found in 2 kg Mo ha^{-1}as basal application which was statistically similar to 1.5 kg Mo ha^{-1} (16.00) as basal application and the minimum number (13.33) of leaves plant^{-1}. The highest seed yield (249.71 kg ha^{-1}) was obtained from 1.5 kg Mo ha^{-1} used as 50% basal + 50% foliar spray possibly due to higher number of pods plant^{-1}, seed pod^{-1} and 1000-seed weight. Significantly the lower seed yield (102.76 kg ha^{-1}) was obtained from control.

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 2014-2015 with two selected OP broccoli lines with BARI Broccoli 1 as check to evaluate their yield performance. In respect of days to 50% curd initiation and curd harvest no significance different was found. The highest curd length (14.78 cm) was recorded from the line BOI-014. The highest curd weight/ plant (456.10g) was obtained from the line BOI-014 which was followed by the check variety (402.80g) while the lowest curd weight/ plant (349.30 g) was obtained from the line BOI-002. The highest marketable curd weight/ plant (615.10 g) was recorded from the line BOI-014. While the lowest marketable curd weight/ plant (528.00g) was recorded from the line BOI-002. The highest per hectare curd yield (24.68 t) was recorded from the line BOI-014 followed by the check variety (23.64t). On the basis of earliness, uniform curd shape, compactness and yield the line BOI-014 was selected for regional yield trial to verify the yield performance.

Regional yield trial of op broccoli line

An experiment on the regional yield trial of open pollinated broccoli lines was conducted for the evaluation of their performance at different locations during the period of 2014-15. The treatments were newly developed open pollinated broccoli line viz. BORai002 and BARI Broccoli-1 as check. All horticultural traits including the yield parameters were studied in different locations. The line BORai002 produced higher Individual curd weight (249.7 g) than the check variety BARI Broccoli 1 (243.9 g). Curd yield per hectare was also higher in the line BORai002 (11.18 ton) than the check variety (11.08 ton). It was observed that the selected line PVRai005 showed superiority over the check variety because of its curd length, breadth, yield and crop duration. Considering above results the line BORai002 is about a week earlier than BARI broccoli 1 and it is flat and relatively short type which has the seed production potentiality also. Individual curd weight (249.7 g) as well as curd yield (11.18 t/ha) were measured in the line BORai002 than the check variety. So it may be release as another open pollinated variety.

Effect of NPKS on the growth and yield of broccoli

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, Rangamati Hill district during 2014-15 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 (8.88 t/ha) was observed in T_{14} treatment and lowest (4.60 t/ha) in T_6 treatment followed by control treatment. In both the low yielded treatment phosphorus was nil. The optimum fertilizer for BARI Broccoli1 cultivation could be $N_{140}P_{75}K_{40}S_{36}$ whereas the recommended dose was $N_{140}P_{50}K_{80}S_{24}$. Next year research is necessary for final confirmation.

Determination of fertilizer requirement of broccoli

The experiment comprising eight treatments based on fertilizers and manures. T_1= $N_{150}P_{50}K_{80}S_{30}Zn_5 B_2 Mo_1$ (N as PU) as a check, T_2= $N_{150}P_{50}K_{80}S_{30}Zn_5 B_2 Mo_1$ (N as USG), T_3= $N_{180}P_{53}K_{83}S_{20}Zn_2 B_1Mo_{0.8}$ (N as PU), T_4= $N_{146}P_{22}K_{62}S_{20}Zn_2 B_1Mo_{0.8}$ +3 ton PM (N as PU), T_5= $N_{126}P_{22}K_{62}S_{20}Zn_2 B_1Mo_{0.8}$ +3 ton PM (N as USG), T_6= $N_{138}P_{46}K_{58}S_{20}Zn_2 B_1Mo_{0.8}$ +5 ton CD (N as USG), T_7= N, P, K, S, Zn , B, Mo (N as Prilled Urea)(BARC, 2005) and T_8= Native fertility (control) was conducted at Regional Agricultural Research Station, Akbarpur, Moulovibazar during rabi season of 2014-15 to evaluate the comparative performance of these packages for sustainable broccoli production. Almost all the traits showed significant variations in terms of yield and yield related parameters. Curd length and breadth were highest (15.22 cm and 15.86 cm, respectively) for treatments T_6 and T_5, Again weight of individual curd was highest (433.33 g) in T_6 and then for T_5 (417.42 g) and T_7 (413.86g) and all of them are statistically similar. Highest yield was also observed in T_6 (16.04 t/ha) and 15.45 t/ha for T_5, 15.32 t/ha for T_7 which are also statistically similar. Treatment T_6 ($N_{138}P_{46}K_{58}S_{20}Zn_2 B_1Mo_{0.8}$ +5 ton CD (N as USG) showed best performance in terms of yield and yield relatede traits. The trial should be continued for the next year for confirmation.

Cabbage

Performance of cabbage lines at different planting time

The experiment was conducted at the research field of Olericulture Division, Horticulture Research Centre, BARI, Gazipur, during October 2014 to February 2015 to study the performances of cabbage lines at different planting dates. The treatment consisted of two planting times (2nd November 2014 as P_1 and 2nd December 2014 as P_2) as factor A and Five cabbage lines/varieties (Atlas – 70, BOC 0025, BOC 0024, BOC 0020 and BD-7766) as Factor B. The highest marketable head weight (1.56kg) and highest yield was found best (58.80 t/ha) from BOC 0020 when combination with 2nd December planting. The lowest yield (34.54 t/ha) was produced by BOC 0025 when coupled with 2nd November planting date. However, it should be needed to study with extending the planting time (about 15 days interval) with more varieties.

Bitter gourd

Evaluation of bitter gourd lines of F_8 progenies in summer season

Eleven bitter gourd lines of F_8 progenies of AVRDC source were evaluated with a check variety BARI Karala 1 in the Vegetable Division, HRC, BARI, Gazipur in the summer season of 2014. The lines varied significantly for their response to all the characters studied ($P<0.05$), except duration of fruit harvest (DH) and per cent non fruit set ($P>0.05$). Of these, days to 1st female flower open (DFF) ranged from 20-45, node orders of 1st female flower open (NFF) 7-27. The line AVBG1325 took minimum days (20) to 1st female flowering which statistically followed in five lines AVBG1324, 1308, 1320, 1323 and 1310 (21-30). Five lines AVBG1320, 1324, 1325, 1308 and 1323 were early relative to female flowering node (7-10). Fruit length and diameter ranged from 9.6-23.5cm and 3.1-4.4cm respectively. The lines also varied widely for marketable fruits per plant (MF/pl), average fruit weight (AFwt) and yield per hectare (Y/ha) which ranged from 17-54, 51.0-178.9g and 9.8-21.7 tons respectively. Six lines AVBG1301, 1308, 1323, 1324, THMC143 and THMC167 produced moderately higher fruits (27-54/ plant) than the check variety (23/plant). Maximum fruit weight was recorded in AVBG1327 (178.9g) followed by AVBG1310 (153g) which was significantly higher than the check (134g). All the lines except one (AVBG1320) were statistically similar for Y/ha. Four lines (AVBG1301, 1310, 1327 and THMC167) had higher yield (18.9-21.7 tons/ha) then the check (17.9 tons). DH and non fruit set ranged from 15-39 days and 11.2-60.1% respectively. The lines varied widely for fruit fly infestation (FflyInfest) ($P<0.05$) (5.1-15.7%). Four lines AVBG1304, 1310, 1327, THMC167 and the check variety had lower FflyInfest (5.1-8.1%), No epilachna beetle infestation (EpibeetleInfest) was observed in the lines. Similarly no infection (0.0%) of downy mildew, powdery mildew, leaf spot (LS) and virus diseases was recorded in these lines. Based on the characters studied and visual observation of fruit color, shape and size four lines AVBG1301, THMC143, THMC167 and AVBG1310 were found promising as variety.

Off season evaluation of bitter gourd lines of F_8 progenies

Nine bitter gourd lines of F_8 progenies of AVRDC source were evaluated with two check varieties BARI Karala 1 and commercial Hybrid Tia at the experimental field of Vegetable Division, HRC, BARI, Gazipur in the winter season of 2014-2015 to select suitable lines for off season production. The 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), duration of fruit harvest (DH), marketable fruits per plant (MF/pl), average fruit weight (AvFtWt), fruit length (Fl), genetic potential equivalent yield per hectare (GPEY/ha) and per cent fruit fly infestation (FtFlyInfest) ($P<0.05$). Five lines AVBG1324, 1323, 1320, 1308 and 1327 were early relative to DFF (38-57). Six lines AVBG1320, 1323, 1324, 1308, 1310 and 1327 produced female flower in the lower node (9-16). Absolutely narrow male-female sex ratio ranging from 1:1 to 3:1 which is highly desirable was recorded in all the lines. DH was higher almost in all the lines (19-26 days) than the check varieties (13-17 days). Seven lines produced higher fruits (7-20/ plant) than the check varieties (6/ plant). AvFtWt ranged from 16.9-97.6g. Three lines (AVBG1301, 1323 and 1324) produced medium-long fruits (13.4-19.6cm). Three lines AVBG1324, THMC143 and AVBG1323 produced higher yield (9.3-11.7 tons/ha) than both the checks (3.7-8.5 tons/ha). Five lines showed low bitterness and four medium. FflyInfest varied from 8.2-25.2%. Lower infestation was observed in seven lines (10.4-17.4%). No incidence of virus disease was found whereas significant powdery mildew (PM) infection was observed in the lines including checks. Two lines AVBG1327 and THMC167 were resistant to PM under field condition, six moderately resistant (MR) and one (AVBG1323) moderately susceptible (MS). Based on DH, MF/pl, AvFtwt, fruit length, yield/ ha and disease reaction and visual looking fruit for shape, size and color two lines AVBG1324 and THMC143 were found promising as off season varieties (winter season) which may be selected for regional yield trial.

Secondary yield trial in bitter gourd

The trial was conduced at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in summer 2014. Five lines of bitter gourd and BARI Karala 1 as a check were included in the study to select superior one with higher yield and better quality. The lines varied significantly for their response to fruit length (FL), fruit diameter (FD), marketable fruits per plant (Mft/Pl), and per cent fruit fly infestation (Ftfly) ($P<0.05$). Of these, FL varied from 12.1-22.1cm, FD 3.5-4.7cm, Mft/Pl 14-37 and Ftfly 4.5-11%. Two lines MC117-1-2 and 117-1-3 produced significantly higher number of Mft/Pl (37 and 32, respectively) than the check and others (14-24). Significantly lower FtFly was observed in the lines (4.5-7.4%) over the check variety (11.6%). The lines were similar for rest of the characters ($P>0.05$). Two lines MC117-1-3 and 117-1-2 out yielded (MY/Pl: 3.7 and 3.3kg respectively; MY/ha: 21.2 and 18.7t respectively) the rest of the lines and check (MY/Pl: 2-3kg; MY/ha: 11.2-17.0t). Considering all the parameters studied, homozygosity of the lines; and visual observation of fruit color, shape and size two lines MC117-1-2 and 117-1-3 were found promising as variety which may go to regional yield trial. Rest of the lines may be used in inbred development program.

Inbred development in bitter gourd

The trial was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in the summer season of 2014. One S_2, one S_3,, one S_5, two S_6 and one S_7 progenies of bitter gourd lines were advanced to S_3, S_4, S_6, S_7 and S_8 generations respectively to develop variable bitter gourd inbred lines for using in the hybrid development program. Wide variation was found in the lines for duration of fruit harvest which ranged from 20-31 days, fruit length 6-25.1cm, fruits per plant 16-28, average fruit weight 30-129g, yield per plant 0.8-2.8kg and fruit fly infestation 19-28.5% while narrow variation for days to 1st female flower open 30-34, node order of 1st female flower open 19-25 and fruit diameter 3-3.8cm. Best individuals from every line of bitter gourd were selected and selfed. Three lines were found homozygous morphologically. Seeds of the rest S_2 to S_5 progenies of bitter gourd lines were stored for advancing S_3 to S_6 progenies respectively in the next year.

Bottle gourd

Evaluation of bottle gourd lines for winter season

The study was conducted at the research field of Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur during winter season of 2014-15 to select superior lines of bottle gourd for winter season. Sixteen lines/ variety of bottle gourd were included in this study. The maximum inter cluster distances were recorded between the cluster III and IV (75.04) followed by cluster III and V (44.54). The intra cluster distance varied from 0.00 to 0.45, maximum being from cluster V that comprised of four genotypes of diverse origin, while the minimum distance was observed in cluster III and IV that comprised of only one genotype. It revealed from the study that yield was mainly contributed by fruits per plant, fruit weight, fruit length, fruit diameter, days to first harvest. The number of fruits per plant, average fruit weight had maximum direct effect on yield. Considering the above mentioned characteristics three diverged clusters viz., cluster I (SL133A, SL136B, SL137A, SL149C), cluster IV (SL151C) and cluster V (SL146, SL146A, SL151D, SL153) were selected for high yielding bottle gourd variety development as well as inbred development for crossing of hybridization programme.

Evaluation of summer bottle gourd lines

An evaluation trial was conducted at the central research farm of Olericulture Division, HRC, BARI, Gazipur during *kharif* season of 2014 to observe yield and yield contributing characters of some selected bottle gourd lines with local check variety. The test lines including check variety differed significantly for their response to most of the parameters. The line LS 66-4-1 and LS 142 flowered earlier (42 days) followed by LS 122-7 (43 days) while the line LS 134 flowered last (62 days). The maximum number of fruits per plant and weight of fruit per plant was recorded from the line LS 62-3-2 (11 and 16.83 kg respectively) while the minimum number of fruits from LS 128 (3 and 3.1kg respectively). The longest fruit was found in the check variety BARI Lau 4 (47.49 cm) while the line LS 122-7 produced the shortest fruit (13.84cm). Maximum fruit diameter (15.69 cm) was recorded from the line LS 134 as it was round in shape and minimum (9.35 cm) from LS 132. A wide range of variation was observed in the fruit yield of the selected bottle gourd lines. The highest yield (44.30 t/ha) was obtained from the line LS 62-3-2 followed by LS 66-4-1 (34.22 t/ha) and the check variety BARI Lau 4 (30.06 t/ha) while the lowest yield was found in the line LS 128 (8.16 t/ha). Considering earliness, higher yield and yield performance the lines LS 62-3-2, LS 66-4-1, LS 57-5-1, LS 127, LS 136, LS 122-7 and LS 134 may be selected for further evaluation next year.

Preliminary yield trial of bottle gourd lines for summer season

The study was conducted at the research field of Olericulture Division of Horticulture Research Centre, BARI, Joydebpur during April to September 2014 to select superior lines of bottle gourd for summer season. Ten lines of bottle gourd were included in this study. The genotypes differed significantly for all the characters studied. Days required for 1st harvest ranged from 71.00 to 78.00 days. Significant variation was observed in bottle gourd lines for fruit length and fruit diameter. The lines LS136 and LS148 produced the highest fruit length (38.00 cm), while the widest fruit diameter was observed in line LS146 (15.33 cm). The highest number of fruits per plant was found in LS146 (13.00) followed by LS141 (9.67), LS150 (9.33), while the highest average fruit weight was obtained from the line LS152 (1.90 kg) followed by LS141 (1.57 kg). Maximum yield was contributed by the line LS146 (33.73 t/ha) closely followed by LS141 (29.67 t/ha), LS150 (28.67 t/ha), while the lowest was in LS136 (10.20 t/ha) followed by LS133 (13.47 t/ha), LS137 (14.13/ha). Considering earliness, high yield, fruit color and acceptable fruit size, shape 5 lines LS141, LS146, LS150, LS151 and LS152 were selected for further evaluation during summer season cultivation.

Regional yield trial of winter bottle gourd lines

Two advanced bottle gourd lines including one check variety were evaluated at six locations of BARI research stations, during winter season of 2014-15 to observe their yield and yield potentiality at different locations. On an average, the advanced line LS 0026-5-3 produced the highest number of marketable fruits (11) per plant followed by the check variety BARI Lau 3 and the lowest in LS0012-5-3 (7). The corresponding yield was also highest in case of the line LS 0026-5-3 (44.87 t/ha) followed by the check variety BARI Lau 3 (35.94 t/ha), LS 0012-5-3 (29.87 t/ha). The fruit size and shape and colour of (deep green) of the fruit was found better in the advanced lines LS 0026-5-3 compared to the line LS 0012-5-3.

Vine pruning technique for higher production of bottle gourd varieties/lines in summer

The experiment was conducted at the research field of Olericulture Division, Horticulture Research Center, BARI, Joydebpur, Gazipur during the summer season of 2013-2014 with four bottle gourd varieties/lines (BARI Lau-3, BARI Lau-4, LS 0012-5-3 and LS 0026-5-3) and three pruning viz: P_1-Pruning of two vine stage, P_2-Pruning of 3 vine stage and P_3-Pruning 4 vine stage (each vine contains main branch) to observe the effect of pruning on the maximization of vine production in bottle gourd. The maximum number of harvested vine per plant (118) was resulted in LS 0026-5-3 along with four vine pruning stage (V_4P_3). The highest vine yield (10.73t/ha) was recorded from the line LS 0026-5-3 when the vines were pruned at four side vine stage (V_4P_3) which was statistically followed by the same line when the vines were pruned two side vine stage (V_4P_1) and the lowest vine yield was recorded from the BARI Lau-4 (6.62 t/ha) when it was pruned at two side branch stage (V_2P_1).Considering the findings of the study LS 0026-5-3 along with pruning of terminal shoots four vine stages can be recommended for better vine production in bottle gourd for use as leafy vegetable.

Pumpkin

Collection and evaluation of pumpkin lines during winter season at hill valley

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2014-15 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 node order of first female flower (NFF), fruit length(FL), fruit girth(FG), flesh thickness(FT), individual fruit weight(IFW), yield and TSS(%). Of these, NFF ranged from 16.3-24.3, FL 8-44, FG 43-97, FT 2.3-6.4, yield (t/ha) 9.62-17.40 and TSS(%) 6-12.5. Minimum node order of first female flower (16.3) was observed in CMRai001 which was statistically similar to CMRai003. The highest yield (17.40 t/ha) was found in CMRai010 followed by CMRai013 (17.38 t/ha) and lowest (9.62 t/ha) was found in CMRai001 treatment. Considering the yield performance of all the genotypes CMRai001, CMRai002, CMRai004, CMRai006, CMRai008, CMRai010, CMRai012 and CMRai013 were found promising for this first year. All of them were selected for further confirmation of their performance in next year.

Regional yield trial of advanced pumpkin lines

The study was conducted at four regional stations of BARI to test the adaptability of the lines over a wide range of environment. Four advanced lines and BARI Mistikumra-1 and BARI Mistikumra-2 as check were included in this study. Among the locations, BARI Mistikumra 1 produced higher fruits per plant and the lines PK 71-9-6-10-3 produced higher yield at Hathazari. Mean of the locations revealed that BARI Mistikumra 2 produced the higher number of fruits per plant and the lines PK 20-2-2-11-1-4-3 produced higher yield (34.12 t/ha) . PK 20-2-1-1-8-7-5 was found promising for green purpose and PK 71-9-6-10-3as mature purpose for varietal release with respect to fruits per plant and yield per hectare.

Inbred development in pumpkin

The trial was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in the winter season of 2014-15. One S_0, one S_1, one S_4, two S_5, one S_6 and one S_7 progenies of pumpkin lines were advanced to S_1, S_2, S_5, S_6, S_7 and S_8 progenies respectively to develop variable pumpkin inbred lines for the development of commercial hybrid varieties. Wide variations were found among the lines for days to 1st female flower open which ranged from 46-65, node order of 1st female flower open 13-24, yield per plant 11.4-21.5kg and yield per hectare 22.8-43t while narrow variation for fruits per plant 4-6, average fruit weight 1.8-4.9kg, TSS 6.8-9.1% and flesh thickness 3.4-4.6 cm. Best individuals from every line were selected and selfed. Two lines were found homozygous morphologically, seeds of which were stored for using in the hybrid development program in future..Seeds of the rest five lines were preserved in the working gene bank for advancing S_0 to S_1, S_1 to S_2, S_4 to S_5 and S_5 to S_6 progenies in the next year.

Heterosis in pumpkin

The experiment was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur during the winter season of 2014-15. Nine hybrids of pumpkin and their parents were included in this study to estimate heterosis relative to mid parent and heterobeltiosis, and select better hybrids. Six hybrids (hybrid 21, 23, 26, 27, 28, and 29) out nine exhibited significant positive heterosis relative to mid parent for fruits per plant (16.6-68 %), yield per plant (39.7-114 %) and yield per hectare (35.7-110 %). Similar trend of heterosis was also observed in these hybrids for those characters (fruits/plant: 19.8-61.8 %, yield/plant: 21.9-108.1 % and yield/ha: 21.7-107.1 %) relative to heterobeltiosis. Based on the characters studied for mid parent heterosis and heterobeltiosis, visual looking of fruit outside and inside, and plant health at least five hybrids (hybrid 21, 23, 26, 27 and 28) may be selected for testing in regional yield trials.

Regional yield trial of pumpkin hybrids

The experiment was conducted with one hybrids and either two or one check variety at Joydebpur and Jamalpur locations of BARI during the winter season of 2014-15. The hybrids were performed similar for their response to fruits per plant, average fruit weight (AvFtwt), and yield per hectare (Y/ha). Fruits per plant of BARI Hybrid Mistikumra 1 (proposed) were higher (7.7) than other hybrid CM14 Hybrid 15 (3.8) or than the check variety (3.8). The proposed hybrid and check variety produced family sized fruit (2.90 kg) where as the other hybrid produced larger sized fruit (7.74 kg) that can be sold in pieces. Yield of the two hybrids were higher (44.77-46.40 t/ha) than the check variety (18.82 t/ha). Fruit fly infestation was found less in hybrids compared to check variety at Joydebpur location. Considering yield attributes and yield BARI Hybrid Mistikumra 1 (proposed) having smaller sized fruits and CM14 Hybrid 15 having larger sized fruits were found better performer compared to BARI Mistikumra 1.

Other gourd

Regional yield trial of ridge gourd hybrids

The experiment was conducted with five hybrids and BARI Jhinga 1 as check variety at four locations of BARI which include Joydebpur, Jamalpur, Patuakhali and Phartali in summer seasons of 2014. Over the locations, fruit per plant ranged from 20 to 37 and maximum was harvested from Hybrid 1 followed by Hybrid 4 and Hybrid 6 whilst minimum from BARI Jhinga 1. The range of average fruit per plant was 136.4-167.7 g with a mean of 152.0 g over the studied locations. Combined result indicated the range of 12.47-25.95 t per ha and highest was in Hybrid 1, followed by Hybrid 4 and the lowest was in BARI Jhinga 1. Fruit infestation was not varied greatly in Joydebpur and Jamalpur location among the ridge gourd hybrids compared to the check variety and the range was 11.1-14.2. Among the test hybrids Hybrid 1 was found the best performer over locations followed by Hybrid 4 and Hybrid 4. Further trial with these selected hybrids is now continuing in the experimental field of HRC, BARI for proposing Jhinga hybrid variety.

Observational yield trial of snake gourd lines

An evaluation of seven genotypes of snake gourd was conducted at Olericulture Division farm, HRC, Bangladesh Agricultural Research Institute, Gazipur during the summer season of 20014-15 to developed high yielding snake gourd variety. Wide ranges of variability were found in the studied characters among the genotypes. The genotypes TA 111-2 took the maximum days (64.88) to first female flowering opening which was significant differences with other six lines. Maximum total number of fruits per plant was found from TA 101-1 (40.42) which was statistically similar to TA 108-1(39.09) and TA 102-1 (37.58) while minimum from TA 111-2 (16.14) and TA 109-1 (21.73) were not at par with previous. The line TA 108-1 gave significantly higher yield per hectare (32.34 tons) closely followed by TA 101-1 (25.44 tons), TA 102-1 (25.02 tons), TA 103-2 (21.70 tons), and TA 110-1 (21.64 tons) and statistically lowest yielder was TA 111-2 (9.77 tons). TA 101-1, TA 102-1, TA 103-2, TA 108-1 and TA 110 genotypes showed better performance in respect of number of fruits/plant, fruit length, individual fruit weight, yield/plot and some other characters. The trial May be recommended for next year trail.

Advanced yield trial of sponge gourd lines

An experiment was conducted at Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the summer season of 2014 to evaluate performance of eight snake gourd genotypes. The genotypes were LC 13-1, LC 9-4-1(W), LC 1-1, LC 9-4-4, LC 3-8-2-1, LC 3-8-10-5, LC 9-4-1 and LC 1-7-8-1. Wide ranges of variability were found in the studied characters among the genotypes. Maximum total number of fruits per plant was found from LC 1-7-8-1 (33.46) which were statistically similar to LC 3-8-10-5 (33.00), LC 1-1 (32.90) and LC 3-8-2-1 (31.13) while minimum from LC 13-1 (9.20). LC1-1 genotype provided maximum marketable yield (6.62 kg/plant) and minimum from LC 13-1 (2.50 kg/plant). LC 1-7-8-1, LC 3-8-10-5, LC 1-1 and LC 3-8-2-1 genotypes showed better performance in respect of number of fruits/plant, fruit diameter, yield/plant and some other characters so above lines may considered for next year trial. The genotypes LC 13-1, LC 9-4-1 may utilize as good breeding material. However, four of eight lines have been considered for next year trial and a varietal development programme may be taken using above six genotypes.

Advanced yield trial of ash gourd

The study was conducted with seven ash gourd lines at the research field of Olericulture division of HRC, BARI, Gazipur during summer season of 2014-15. The days to 1st male flowering opening earlier in BH002 (34.67) followed by BH033 (35.33), BH001 late in BARI Chalkumra 1 (41.75) . The days to 1st female flowering open was earlier in BH002 (42.40 days) followed by BH001 (45.15) and BH029 (46.30) and late in BARI Chalkumra 1 (49.22). Days to 1st harvest was earlier in BH001 (54.72) followed by BH029 (56.95 days) and BH002 (58.03) and late in BARI Chalkumra 1 (62.65). The number of fruit/ plant was height in BH001 (8.45) followed by BH002 (7.55) lowest in BARI Chalkumra 1 (6.57). Individual fruit weight was higher in BH002 (1.47 kg) and followed by BH001 (1.37) and lower in BH033 (1.07kg). Fruit length was highest in BH0029 (18.75cm) followed by BH002 (18.45cm) and BH001 (17.55cm) lowest in BH034 (16.75 cm). Fruit diameter was highest in BH0029 (12.02cm) followed by BH002 (10.32 cm) and lowest in BH001 (10.00cm). The yield per plant was higher in BH001 (11.67 kg) followed by BH002 (11.23 kg) and lowest in BARI Cahalkumra 1(7.17kg). Among the advanced line yield/ t/ha was highest in BH001 (38.91 t/ha) followed by BH002 (37.42 t/ha) and lowest in BARI Chalkumra 1 (23.90 t/ha).

Regional yield trial of selected cucumber lines

The experiment was conducted with two selected cucumber lines including one commercial variety as check at three different locations across the country which included Joydebpur, Jamalpur and Akbarpur during February to June 2014 for their yield, quality and virus resistance. Results indicated that both lines showed different performance at different location. In case of fruits per plant, the highest value was observed from the advanced line CS 0080 at Akbarpur (13.99) followed by the check (12.00) in Jamalpur. But in Akbarpur the lowest fruit number was obtained from the check variety (6.47). Lowest fruits per plant were obtained from the advanced line in Joydebpur (6.32). Both the lines performed well in respect of average individual fruit weight. The highest individual fruit weight was obtained from the line CS 0080 in Jamalpur (266.22g), whereas in Joydebpur it was highest in CS 0079 (260.9g). In case of yield the average highest yield was obtained from the line CS 0080 (18.32 t/ha). This line has performed best in this regard from all the three locations. Both the lines (CS0080, CS 0079) showed less susceptible to virus diseases. 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 hybrid pointed gourd lines

The experiment was conducted with six promising lines of hybrid pointed gourd and BARI Potal 1 as check at three locations of BARI which included Jamalpur, Jessore and Ishurdi during June to November 2014 to observe the performance of advanced cauliflower lines at early winter season to evaluate the performance of six promising lines of hybrid pointed gourd and BARI Potal 1 was used as check. The line PG009xM_2 gave the highest number of fruits per plant (158) while the lowest number of fruit per plant (105) was obtained from PG008xM_1. The highest yield (41.30 t/ha) was obtained from PG009xM_2 and the lowest yield (27.76 t/ha) was obtained from PG008 x $M_{1.}$ The hybrid PG009xM_2 and PG014xM_1 showed better performance in respect of yield and horticultural traits. It may be selected for further RYT for confirmation of the result.

Regional yield trial of squash lines

A study on 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 2014-2015 to develop good OP varieties having seed production ability to the growers. Among the test lines, the line CP 0003 showed highest potentiality with respect to fruit number per plant (4.27) in Jessore. Whereas the average highest number of fruits per plant was performed by the line CP 004 (3.72). Among the studied lines at three locations, the highest yield was obtained by the line CP 0003 (45.67 t/ha) in Jessore and the lowest was obtained from the line CP 0002 (22.15 t/ha) in the same location. The corresponding yield was the highest against yield performance in case of CP 0003 (43.79 t/ha) followed by the check line Bulam house (38.89 t/ha). In case of insect pest infestation, the lowest infestation of fruit fly (10.30%) was observed in CP 0002 which was followed by CP 0001 (11.15%) and the check variety Bulam house was affected higher (14.53%) by the infestation of leaf miner followed by CP 0001(11.59%). Considering yield and yield attributes, the line CP 0003 performed best and may be recommended as variety. The other lines can be selected for further evaluation for development of variety to add new vegetable crop to the growers as well as to the consumers in our country.

Bean

Varietal Improvement

Evaluation of early hyacinth bean lines

The study was conducted with three selected early hyacinth bean lines (MZ Black 2, CB 0160 and CB 0091) with check variety BARI Sheem 1 and BARI Sheem 4 at research field of Olericulture Division, HRC, BARI, Joydebpur, Gazipur during the winter season of 2014-15 to observe their yield 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 (41 days) followed by the line CB 0160 (44 days), while the check varieties BARI Sheem 1 and BARI Sheem 4 needed longer times for flowering (66 and 80 days, respectively). The maximum number of pods per plant (530) was produced by the line MZ Black 2 followed by BARI sheem 1 (440) and the minimum in BARI Sheem 4 (229). The check variety gave the highest pod yield (17.48 t/ha) closely followed by the line MZ Black 2 (16.91 t/ha) and CB 0160 (12.78 t/ha) and the lowest yield in BARI Sheem 4 (10.76 t/ha). Considering higher yield, earliness and quality of pods the line MZ Black 2 and CB 0160 may be selected for further evaluation to develop as an early high yielding hyacinth bean variety.

Regional yield trial of selected bold seeded hyacinth bean lines

An evaluation was conducted with selected two advanced bold seeded hyacinth bean lines (CBR 204 and LPR 125) with a check variety BARI Sheem 4 at Joydebpur, Raikhali, Jessore, Hathazari and Jamalpur locations of BARI during winter season of 2014-15 to observe their yield and yield potentiality and quality of green pod and green seed. On an average, the advanced line LPR 125 produced the highest green pod yield (18.13 t/ha) followed by the line CBR 204 (17.93 t/ha) and the lowest in BARI Sheem 4 (16.61 t/ha). In case of green seed yield the highest yield was obtained form the advanced line CBR 204 (8.33 t/ha) closely followed by the line LPR 125 (7.62 t/ha). Among the locations, in Raikhali and Jessore all the lines showed the best potentiality in respect of both green pod yield and green seed yield compared to other locations. While the lowest pod and seed yield was obtained from RARS Jamalpur for all the lines. Considering higher green pod yield as well as green seed yields the advanced lines CBR 204 and CBR 125 may be recommended for release as a bold seeded hyacinth bean variety.

Evaluation of yard long bean lines

The study was conducted with seventeen yard long bean lines along with BARI Borboti 1 as check at the central research farm of Olericulture Division, HRC, BARI, Gazipur during *Kharif* season of 2014 to evaluate some yard long bean germplasm. The test lines including check variety differed for their response to all the traits. In case of days to 50% flowering the lines VS 41 and VS 45 flowered earlier (29 days), followed by VS 20, VS 32 and VS 34 (31 days) while VS 28 (42 days) flowered last. The highest number of pods per plant was obtained from the line VS 21 (38.50) while the lowest in VS 39 (9.80).The line VS 21 produced the maximum weight of pods per plant (697.50 gm) and the line VS 39 produced the minimum (158.40 gm). The highest yield was found in the line VS 21 (23.25 t/ha) followed by the lines VS 49 (17.82 t/ha), VS 20 (12.92 t/ha, BARI Borbati 1 (12.26 t/ha) and the lowest yield was found in VS 39 (5.57 t/ha). Among the lines VS 21, VS 49, VS 20, VS 19, VS 43, VS 34 and VS 46 gave better performance on yield and yield contributing characters. So, these lines may be selected for PYT in next year.

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 six different location of BARI research stations during the winter season of 2014-15. The advanced line PVRai 005 and the check variety BARI Jharsheem 3 produced similar seed yield (4.97 t/ha, and 5.23 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 (5.23 t/h) which was closely followed by the advanced line PVRai 005 (4.79 t/h). Among the locations,in Khagrachari both the advanced lines and check variety showed the best yield potentiality. Moreover, the color, shape and attractiveness of the bold seed of the advanced line was superior to the check variety. So the advanced line PVRai 005 may be recommended for further RYT for confirmation.

Collection and evaluation of garden pea germplasm

An experiment was conducted with nine garden pea germplasm with BARI Motorshuti 1 as check at Regional Agriculture Research Station, Ishwardi, Pabna during winter 2014-15 to evaluate the performance of yield and yield contributing characters of garden pea germplasm. BARI Motorshuti 1 required the lowest duration (86.38 days) for harvest and the maximum duration (109.68 days) required for PS Ish006. The highest 100-seed weight was recorded in PS Ish005 (12.90) and PS Ish009 (12.61). However, the highest pod yield (10.23 t/ha) was obtained from PS Ish005 due to higher pod number per plant and 100-seed weight. The yield of BARI Motorshuti 1 was 9.94 t/ha which was statistically similar to that of PS Ish005. PS Ish001 also performed better considering pod yield (9.76 t/ha). PS Ish005 gave the highest pod yield (10.23 t/ha) due to higher pod number per plant (10.30) and the highest 100-seed weight (12.90). The yield of check variety BARI Motorshuti-1 was 9.94 t/ha. PS Ish001 also performed better considering pod yield (9.76 t/ha). PS Ish005 and PS Ish001 were found promising in first year. So the trial should be continued for confirmation of the results.

Okra

Evaluation of selected okra lines

The experiment was conducted with selected nine okra lines along with BARI Dherosh 1 as local check at Olericulture Division, HRC, BARI, Gazipur during the summer season of 2014. An extensive screening program was done over the lines to evaluate their reaction especially against yellow vein mosaic virus (YVMV) and fruit yield in open field condition. Days to 50% flowering ranged from 41.51 to 52.31 days and minimum was in AE0124 and maximum in AE0163. Maximum weight of tender fruit was in AE0141 and minimum was in AE0130. Fruit length varied from 12.40 to

14.81cm. Long fruit was found in AE0123 and shortest was in AE0122 but fruit diameter was statistically insignificant. Fruit number per plant varied significantly among the lines. It ranged from 14.35 to 34.33. Maximum number of fruit was found in AE0163 (34.33) and followed by AE0146 (33.33) and AE0122 (31.32). Lowest number of fruit per plant was found in BARI Dherosh 1. No insecticide was applied to allow free movement of white fly. The lines AE0122, AE0123, AE0124, AE0130, AE0141, AE0146, AE0163, AE0168, and AE0170 showed highly resistant against YVMV and performed higher yield. These 9 lines were selected for further evaluation.

Adaptive trial of SAVTNet okra lines

The experiment was conducted with 5 lines including BARI Dherosh 1 as local check at Olericulture Division, Horticulture Research Centre, Gazipur, BARI during the summer season of 2014. An extensive screening program was done over the lines to evaluate their fruit yield performance and reaction against yellow vein mosaic virus (YVMV) in open field condition. There was significant different on yield and yield contributing characters. The highest fruit yield per hectare (8.63 t) was produced by SOK003 followed bySOK001 (7.84 t)). All the lines including BARI Dheorsh 1 showed highly susceptible against YVMV and produced low yield. The trial may be repeated with more lines for confirmation of the results.

Regional yield trial of okra

The experiment was conducted with three advanced okra lines including BARI Dherosh 1 as check at five different locations of BARI, Joydebpur, RARS Jamalpur, Ishwardi, Hathazari and Jessore, BARI during May - August 2014 to evaluate the lines for yield performance and reaction against yellow vein mosaic virus (YVMV). There was significant difference on yield and yield contributing characters. The highest fruit yield per hectare (20.90) was produced by AE086 and followed by AE018 (17.36) and AE012 (16.00). The lines AE012, AE018 AE086 showed highly resistant to yellow vein mosaic virus. The line AE086 was found high yielder as well as highly resistant to YVMV in all the locations and may be recommended for new variety of okra.

Other vegetables

Advanced yield trial of open pollinated carrot lines

The study was conducted at the research field of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2014-15 to evaluate the yield performance and good seed production capability of four promising carrot lines. Marketable root yield was obtained from all the lines. CR 0014 scored the highest root yield per hectare (19.21t) followed by CR 0021 (17.52 t/ha). The highest seed yield was obtained by the line CR 0021 (16.53 g /plant) followed by CR 0014 (12.45 g /plant). The test line CR 0014 may be put into RYT with other three lines for variety development.

Regional yield trial of spinach lines

The study was conducted with two advanced spinach lines and one local (check) at four locations which included Joydebpur, Jamalpur, Jessore and Ishwardi during winter season of 2014-2015 to evaluate the performance of the selected advanced lines in different agro-ecological zones. The highest average leaf weight per plant (116.3g) was recorded from the line SO-0048, while the lowest (82.8 g) was from local. The highest average number of leaves (17.0) was observed from the line SO-0048 and the lowest (14.0) from local. Among the tested lines of four locations, the highest average per hectare yield (40.6 t) was recorded from the line SO-0048 followed by SO-0011 (107.3t) and the lowest yield (29.0t) was recorded from the local line. Considering yield and late bolting nature the line SO-0048 may be selected to release as a variety.

Collection, evaluation and conservation of indigenous vegetables

Twenty eight types of underutilized indigenous vegetables (14 vegetable and 14 medicinal) were put under observational trial as monoculture to assess their performance in respect of yield, seed production trend and agronomic practice for growing different time of the year during 2014-15. 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 attempted. 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. In addition, 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), BARI, Gazipur during the season of 2011-12 to onward. 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-0007, MO-0008, MO-0011 and MO-0012 were considered as off-seasonal promising lines having 40g, 40g, 50.57g and 68 g average individual pod weight respectively . These lines were capable to produce flower two to three times in a year. As the plants showed difference in establishment, flowering, pod setting etc in last year. Now, all the plants had established and canopy volume was almost uniform. Therefore, proper evaluation in relation to characterization, floral biology, yield and quality will be studied next year.

Development of propagation techniques for drumstick sapling production

The experiment was conducted at Vegetable Research Farm of Horticulture Research Centre, BARI, Joydebpur during April 2014. There were five selected drumstick lines viz.: MO 0007, MO 0008, MO 0011, MO 0012 and MO 0025 included in this study with two concentrations 1000ppm and 2000ppm of IBA (Indol- Butyric Acid). Nine months old 75cm long stems with diameters of 7-15cm and 7 cuttings of each line were kept in 1000 ppm and 2000 ppm IBA solutions for ten minutes. Then cuttings were transplanted in 12 inches and six inches soil filled (mixture of 1/3rd loamy soil+1/3rd sand+ 1/3rd decomposed cow dung) poly bag for root initiations with three replications to develop suitable techniques for drumstick sapling production for commercial use. The line MO0011 (year round pod bearing habited line) showed the highest shoot initiation (4), root initiations (4) and plant survival (3-42.85% and 2-28.57%) when IBA concentration used 1000 and 2000 ppm, respectively. But in the case of control, though shoot and root initiation rate was less than IBA treated ones, the plant survival percent was identical when stem cuttings were treated with 1000ppm IBA concentration. The lowest shoot and root initiation and plant survival was recorded in the line MO 0025 irrespective of using IBA concentration and control. There was no significant difference using IBA concentration. Therefore, further investigations needs to be done to find out the fact for commercial drumstick sapling production.

Year-round production of some selected HYVs and hybrid vegetable varieties in southern and hilly regions of Bangladesh

An experiment was conducted on year round vegetable production at Sadar upazila of Bandarban and three upazilas (Dasmina, Bauphol and Galachipa) of Patuakhali districts during 2014-2015 for assessing the adaptability of selected vegetables (OP & hybrid varieties of BARI and other companies/local) in each location/season and to popularize those vegetables among the farmers and its modern production packages too. The findings revealed that farmers have acquainted with BARI vegetable varieties, specially garden pea, french bean, summer bottle gourd and summer tomato more specifically, BARI varieties like BARI Hybrid Tomato 4, BARI Tomato 14 and 15, BARI Motorshuti 1 & 3, BARI Jharshem 1, BARI Lau 3 & 4, BARI Begun 8, BAR Lalshak 1, BARI danta 1 and BARI Puishak 1. BARI varieties also posses higher BCR compared to company/local varieties. The scenario of production, consumption, distribution and sell per plot indicated that some percent of produced vegetables were consumed by the growers, distributed among neighbor and relatives, while remaining lion share of produced vegetables were sold by which the growers earned hard currency to mitigate other expenditure. Therefore, all the farmers of the project areas were benefited with cultivation of BARI varieties.

Evaluation of mushroom varieties

An experiment was conducted at the Olericulure Division, HRC, BARI, Gazipur during the period from December 2014 to March 2015 to study the varietal performance of 4 oyster mushroom varieties. The yield performance of four mushroom varieties (Pleurotus ostreatus, Pleurotus florida, Pleurotus highking 51 and Pleurotus sapidus) showed significant vitiation. Among the varieties, Pleurotus highking 51 produced maximum effective fruiting body (42.30), biological yield (266.52 g) and marketable yield (220.52g) followed by Pleurotus ostreatus (214.51g) and Pleurotus sapidus (199.22g).

Hydroponics culture

Comparison of different media on capsicum production in simlified soilless culture

The experiment was conducted at the plastic house of Olericulture division of the BARI, Joydebpur, Gazipur during the winter season of 2014-2015. A completely randomized design (CRD) was followed with three replication. The plant height was highest in coco dust 100% days followed by water culture days and rice husk 80%+ saw dust 20% and lower in rice husk 60%+ river sand 40% days. There was significant different in 1st flowering opening. The days to 1st flowering open was earlier in water culture (38.35 days) followed by coco dust100% (39.88 days) and late in rice husk 60%+ river sand 40% (53.47 days). The days to 1st harvest was earlier in water culture (68.85 days) followed by coco dust 100% (71.68 days) and late in rice husk 80% + saw dust 20% (83.15 days) and rice husk 60%+ river sand 40% (76.65 days). The number of fruits/plant was highest in water culture (8.92) and followed by coco dust100% (8.02) lower in rice husk 60%+ river sand 40% (5.22) and rice husk 80% + saw dust 20% (6.47). Individual fruit weight was higher in coco dust100% (81.63g) and followed by water culture (77.28g). lower in rice husk 80% + saw dust 20% (59.03g) and rice husk 60%+ river sand 40% (65.68g).Fruit length was highest in coco dust100% (7.07cm) followed by water culture (6.90 cm). Fruit dia. was highest in water culture (6.47cm) followed by coco dust 100% (6.32cm) lower in rice husk 60% + river sand 40% (4.92cm). The yield/plant was highest in water culture (693.9g) and followed by coco dust 100% (657.3g) lowest in rice husk 60% + river sand 40% (344.3g).

Observation 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. It revealed that the growth of Netted melon plant height ranges from 103-115cm. Days to harvest varied from 82- 95 days. No of fruits per plant was 2-3 fruit, the size of the fruit length varied from 4.6-7.5 and diameter was 11.5-13.4cm. Single fruit weight ranges from 150-200 g. Yield per plant was 300-750g.

Performance trial of institute of simplified hydroponic (ISH) tomato, lettuce, radish and sweet potato in coco dust media on soilless culture

The experiment was conducted at the glass house of Olericulture Division, Horticulture Research Centre, BARI, Joydebpur, Gazipur, during November, 2014 to March, 2015 with ISH supplied seeds. .From the study, Tomato plant height ranged from 168-175 cm. Days to 1st flowering ranges from 56-62 days and 1st harvest 105 – 110 days. Number of fruits per plant ranged from 18- 22. Individual fruit weight varied from 195 - 227g. Fruit size varied from 5.9X5.1 cm - 6.5 X 5.8 cm. Yield per plant ranged from 3.6 – 4.9 kg. Lettuce plant height varied from 23.5 - 25.2 cm. No of leaves ranged from 59-62.5 per plant. Leaf size varied from 18.2X10.2 cm – 23.5X11.3cm. Root length varied from 40.5.-47.5 cm. Total plant yield ranged from 270-386.5 g. Radish plant height varied for 18.7-21 cm. No of leaves ranged for 7.0 - 8.7. Leaf size varied for 11.2X6.6 cm – 17.1X7.0 cm. Root length ranged for 7.7-9.0 cm and Root dia. varied from 3.25-3.6cm. Radish weight ranged from 57.7-59.3g. In Sweet potato the plant height varied from 175-213 cm. No of fruits per plant ranged from 3 -5. Fruit lengths range from 8.4-9.9 cm. Individual sweet potato fruit weight varied from 30.4-53.7g. Sweet potato Yield per plant ranged from 114.6 – 214.8g.

Production of horticultural crops through vertical hydroponics

The experiment was conducted during winter 2014-2015 in Olericulture division, Horticultural Research Center at BARI, Joydebpur, Gazipur. Two high value horticultural crops namely, capsicum and lettuce were selected for growing in three media, coco dust, gravel and water for vertical hydroponics culture. The plant height of capsicum was higher in gravels (46.7 cm) and followed by coco dust (42.3cm) and lower in water culture (38.6cm). Days to 1st harvest earlier in gravels (67.2 days) and late in water culture (68.5 days). The number of fruit per plant was higher in gravels (8.5) and lower in water culture (5.2). Fruit length was higher in gravels (8.4cm) and lower in water (7.2 cm). Fruit diameter was higher in coco dust and gravels and lower in water culture. The individual fruit weight maximum in gravels (88.6 g) and minimum in water culture (72.7g). The highest capsicum yield plant was obtained from gravels (757.0g) followed by coco dust (631.5g) and lowest in water culture (512.4g). Lettuce plant height was higher in coco dust (45.2 70 cm) and lower in gravels (40.6cm). The number of leaves per plant was higher in water culture (30.5) and lower in gravels (23.4). Leaf length was higher in water culture (27.7cm) and lower in gravels (22.9cm). Leaf breadth was higher in coco dust (20.5cm) and lower in gravels (18.7cm). Root length was higher in gravels (46.7 cm) and lower in coco dust (42.2 cm). The highest lettuce yield was obtained from water culture (380.1g) and followed by coco dust (329.8g) and lowest in gravels (233.9g).

Effect of growing media on the yield and quality of strawberry in soilless culture

Strawberry plants were cultured in three different growing media to compare their influence under glasshouse condition at hydroponic facility of Olericulture division, HRC, BARI, Gazipur during winter season of 2014-15. The experimental design was completely randomized block design with 20 replicated plant/pots. There were three types of soilless culture substrates such as solution culture in the tray, coco-dust substrate and coco-dust + sand substrate (60:40) in 12 L plastic container. The concentration of nutrient solution was 1.5 dS/m and pH was maintained at 6.5. Considering dry matter production, leaves dry matter was not affected but root dry matter was much greater (178% and 83% compared to coco-dust and coco-dust + sand, respectively) in solution culture. Fruit weight per plant was higher in solution culture (178% and 137% greater than coco-dust and coco-dust + sand culture, respectively) compared to either of the coco-dust based substrates. The yield was consistently contributed by number of fruits/plant and average fruit weight. The qualities of strawberry fruits except total soluble solids were not differed significantly in all growing condition. In general plant grown in solution culture performed better than plants grown in coco-dust and coco-dust +sand substrate. This study indicates that sole coco-dust or its mixture with sand would not be comparable with solution culture in producing strawberry under soilless hydroponics.

Organic Vegetables

Impact of organic practices on soil microbial populations, soil health and crop yield

After cultivating 18 crops of vegetables for seven consecutive years (2008-2015) in an open field, the effects of different application rates of compost (Block A, 15 t/ha with matured compost/y; Block B, matured poultry compost 15 t/ha/year ; Block C, matured poultry compost 7.5 t/ha/year) were compared with the effects of conventional fertilizer (CF) and no application of fertilizer treatments (Block D or Control) for some selected soil chemical properties, microbial populations and crop yield. The results revealed that the pH, concentrations of total nitrogen (N) and the organic matter received from compost treatment were generally higher than those received through CF treatment. The soil microbial biomass, populations of bacteria, fungi and chemical properties increased significantly in the compost-treated soils compared to the CF-treated soil. In most instances, significant increase of available organic matter, N, P, K was observed in the without compost amended soil (D field). However, all microbial population showed significant linear correlations with the organic matter contents of the soils. The organic vegetable yield was reached identical to conventional field implying that organic yield is increased over the year after adequate amount application of compost and yield would be stable after the soil fertility has been established. High organic matter content in the soil along with microbes richness ensure the improvement of yield as tropical and subtropical climates threat to deposition of OM but organic practices protect the OM of the soil and alleviate the adverse effects on vegetable growth. In conclusion, application of organic compost at the rate of 15 t/ha/year, is adequate on the basis of vegetable yields and soil chemical, microbial properties in open field cultivation under subtropical climatic conditions.

Effect of different sources of organic nutrients on the production of cabbage

An experiment was conducted at Regional Agricultural Research Station, Jessore during rabi season 2014 to find out the effect of different organic manures in combination with chemical fertilizers on the production of cabbage. Eight treatments viz. T_1 = 100% Recommended dose of chemical fertilizers (RDCF), T_2 = Cowdung 10 t/ha + 75% of RDCF, T_3 = Poultry manure 3 t/ha + 75% of RDCF, T_4 = Vermi compost 1.5 t/ha 1.5 t/ha + 75% of RDCF, T_5 = Kitchen waste compost 3 t/ha + 75% of RDCF, T_6 = Tricho-compost 3 t/ha + 75% of RDCF and T_7 = Native fertility, were used in this experiment. There were significant variations among the treatments in all cases accept some parameters. However, marketable head weight was found maximum (1.71 kg) in the treatment T_1 (100% Recommended dose of chemical fertilizers) followed by the treatment T_3 and T_6 by 1.67 kg in both cases, while the minimum was in T_8 (1.25 kg).The highest yield (85.75 t/ha) was also obtained from the treatment T_1 (100% Recommended dose of chemical fertilizers) closely followed by the treatment T_3 (83.67 t/ha) whereas the lowest yield (52.50 t/ha) was collected from the treatment T_7 (Native fertility).

Plant physiology

Dry matter partitioning of two cultivars of bush bean as influenced by nitrogen fertilization

A field experiment with bush bean (*Phaseolus vulgais* L.) comprising two varieties (BARI Jharsheem-1 and BARI Jharsheem-2) and five levels of N (0, 75, 100, 125 1nd 150 kg N/ha) was conducted at the field of Plant Physiology Section of HRC during the rabi season of 2014-2015 to determine the optimum nitrogen dose on growth and yield of pods by influencing dry matter partitioning of different parts of two varieties of bush bean. BARI Jharsheem-1 and BARI Jharsheem-2 were almost similar in growth rate. But BARI Jharsheem-1 produced higher total plant dry matter, chlorophyll content index (CCI), and green pod yield whereas BARI Jharsheem-2 gave higher number of leaves/plant and Fv/Fm. Application of 150 kg N/ha gave the highest plant height, number of leaves/plant, CCI, Fv/Fm, maximum growth rate viz. CGR, RGR and NAR, maximum LAI, the highest pod numbers/plant, weight of green pods/plant and green pod yield per hectare. Green pod yield per hectare increased linearly with the increased level of N. The dry matter accumulation and its partitioning into various components (leaf, stem and pod) increased significantly with the increased level of N up to 150 kg/ha in BARI Jharsheem-1 and up to 125 kg N/ha in BARI Jharsheem-2. BARI Jharsheem-1 treated with 150 kg N/ha gave the maximum green pod yield (140.60 g/plant, 16.45 t/ha) which was identical with the same variety at 125 kg N/ha (138.30 g/plant and 16.21 t/ha). BARI Jharsheem-2 also produced the highest green pod yield at 150 kg N/ha (132.6 g/plant and 15.17 t/ha) being statistically similar at 125 kg N/ha (125.50 g/plant and 14.89 t/ha).

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 2014-2015 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 4.11 followed by T_1 treatment.

Effect of drought on tomato varieties at germination and early seedling growth stages

A lab experiment was conducted on tomato (*Solanum lycopersicon* L.) at the Plant Physiology Laboratory of HRC, BARI, Gazipur during November 05, 2014 to November 30, 2014 to find out the drought tolerant varieties at germination and seedling stages. Twelve varieties and four osmotic stress levels viz. control (without PEG), 10% , 15% and 20% PEG solution were used in this experiment. Distilled water was used as control. Relative germination rate, relative percentage of shoot and root length, root-shoot ratio, relative percentage of seedling fresh weight and seed vigour were found to be affected by PEG levels. The varieties BINA Tomato 4, BINA Tomato-5, Bahar, BARI Tomato-3, BARI Tomato 5, BARI Tomato 8 and BARI Tomato 14 showed better performance at 10 and 15% PEG than other varieties in respect of relative germination rate, relative percentage of shoot and root length, relative percentage of seedling fresh weight and seed vigour. At 20% PEG, BINA Tomato-5 and Bahar gave 18.80 and 29.32% relative germination rate and other varieties gave relative germination rate in the range of 2.08 to 7.01%.

Effect of GA_3 on seed yield and yield attributes of 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 2014-2015 at the field of plant physiology section of HRC. Thirty two 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, yield and yield attributes of broccoli. GA_3 60 ppm gave maximum growth and head yield of broccoli.

Note: Seed harvest was not possible because seed crop was totally destroyed by hail storm.

Screening of spinach genotypes against salinity during germination and early seedling growth stages

Eleven spinach genotypes were tested against varying levels of salinity (0, 2, 4, 6, 8 and 10 ds/m) in petri dish at the Plant Physiology laboratory of HRC, BARI, Gazipur during January 01, 2015 to January 30, 2015 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 and seed vigour were found to be affected by salinity levels. The genotypes BD-4323, BD-4333, BD-4339 BD-4342 and BD-9659 showed better performance in respect of germination percentage, relative germination percent seed vigour at 2 ds/m and 4 ds/m. These genotypes gave higher percentage of germination, relative germination rate, and seed vigour at 6, 8 and 10 dS/m than other genotypes and survived up to 10 days after germination.

Screening of sweet gourd genotypes against salinity during germination and early seedling growth stages

Ten sweet gourd genotypes were tested against varying levels of salinity (0, 2, 4, 6, 8 and 10 ds/m) in petri dish at the Plant Physiology laboratory of HRC, BARI, Gazipur during 2014-2015 to find out the salt tolerant genotypes at germination and seedling growth stages. Distilled water (0 ds/m) was used as a control. Relative germination rate, relative percentage of shoot and root length and seed vigour were found to be affected by salinity levels. The genotypes BD-2212, BD-2232 and BD-9875 showed better performance in respect of relative germination rate, relative percentage of shoot and root length and seed vigour at varying salinity levels.

Effects of GA_3 on germination of lettuce seeds

An experiment having seven concentrations of GA_3 (Control, 10, 25, 50, 100, 200 and 300 ppm) and three soaking time (1, 3 and 6 hr) was conducted at the laboratory of Plant Physiology Section of HRC during November 2014 to May 2015 to improve the germination of lettuce seed. The experiment was laid out in CRD with three replications. The combination of soaking time and GA_3 concentration had no significant effect on germination percentage and seed vigor of lettuce seed.

Disease control

Screening of eggplant germplasm resistant to bacterial wilt

Twenty eggplant accessions were screened for resistance to *Ralstonia solanacearum* grown under artificial epiphytotic conditions during 2014-2015 cropping seasons. Three lines such as SM-284, SM-278 and 5x11 gave resistant reaction under field condition in Gazipur. Twelve accessions of eggplant showed moderately resistant reaction. Four lines showed highly susceptible reaction to *R. solanacearum*.

Screening of tomato germplasm resistant to bacterial wilt

Seventeen tomato accessions were screened to find out bacterial wilt resistant source grown under artificial epiphytotic field conditions during 2014-2015 cropping seasons. Three accessions namely GPT-0015, TLB-182 and LEE-002 gave resistant reaction under Gazipur conditions. Ten accessions of tomato were showed moderately resistant reaction, two lines moderately susceptible and two lines highly susceptible to *R. solanacearum*.

Screening of eggplant vars./lines against root-knot nematode

Twenty eggplant varieties/lines were tested in a nematode infested sick bed for their resistance to root-knot nematode. Among them nine lines were found moderately resistant, two lines moderately susceptible, four lines susceptible and five highly susceptible to root knot nematode.

Screening of tomato var./ line against root-knot nematode

Fifteen tomato varieties/lines were tested in a nematode infested sick bed for their resistance to root-knot nematode. Among them, seven lines showed moderately resistant reaction, five moderately susceptible and three susceptible to root knot nematode.

Screening of tomato germplasm for resistant to tomato yellow leaf curl virus disease

An experiment was conducted at the plant pathology Section, HRC, BARI during winter 2014-15 cropping season to find out resistant tomato germplasm against Tomato Yellow Leaf Curl Virus disease. A total of twenty tomato germplasm were evaluated. Among them, seven germplasm TLB 130, LEE 009, T2, 1008, P13, 1001, P2, and GPT 009 did not show any TYLCV symptom, while BARI Tomato-8 was moderately susceptible. All the germplasm showed highly resistant to resistant reaction except BARI Tomato-8, which was moderately susceptible. Germplasm P9, T1, 1010, 1008, P13, 1001 and GPT-009 performed better in yield. Considering both disease and yield data GPT-009 P9, T1, 1010, 1008, P13, C11 and 1001 were selected for further trial. The selected entries GPT-009 P9, T1, 1010, 1008, P13, C11 and 1001 produced 14.17, 14.67, 15.73, 15.60, 14.33, 15.33, 14.93 and 14.57kg/plot yield, respectively.

Screening of chemicals against *Sclerotinia sclerotiorum* in country bean *in-vitro*

The study was carried out at the Plant Pathology Section, HRC, BARI, Gazipur from March to June 2015. The pathogen was isolated from diseased bean plant at Bogra. Seventeen fungicides including control under nine groups of chemicals were studied. Fungicides were inoculated into PDA medium in different concentrations (10, 20, 50, 100 and 200 ppm). Afterwards, the discs of mycelium-agar with isolates of the phytopathogen were placed on medium containing fungicides and media without fungicides, and incubated at 28° C. The experiment was arranged in a complete randomized design with four replications. Seven fungicides completely control mycelial growth of *S. sclerotiorum.* Among them Bavistin, Rovral and contaf were most effective in inhibiting mycelial growth even in lower doses.

Compatibility study of *trichoderma harzianum* with botanicals, poultry litter, mustard oil cake and fungicides

Botanicals and organic sources such as bishkatali (*Persicaria stagnina),* neem *(Azadirachta indica),* poultry litter, mustard oil cake, and chemicals such as Bordeaux paste, Indofel, Bavistin, Provax and Rovral were tested for compatibility with *Trichoderma harzianum.* Bishkatali, neem, poultry litter and MOC were found compatible with *T. harzianum* for its mycelial growth and spore production. While *T. harzianum* produced mycelium and spore in Bordeaux paste, Indofel and Rovral inoculated PD broth. But no mycelium growth or spore production were observed in Bavistin or Provax inoculated media. Effectiveness of *T. harzianum* against *Sclerotium rolfsii* was tested in presence or in absence of botanicals. Mycelium growth reduced over control about 19.18% and 9.50% due to present of bishkatali and neem leaf powder, respectively in Duel Culture Technique.

Validation and up-scaling of tricho-compost production technology at farmers' level

The experiment was conducted for validation and 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. 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 18.48 ton Tricho-compost and 534 liter Tricho-leachate were produced was produced from four loading from Jessore and Bogra during June 2014 to May 2015.

Determination of transmission mechanism of okra yellow vein clearing mosaic virus (OKYVCMV)

An experiment was conducted in the field house of vegetable division, HRC, BARI Gazipur. The first seed sowing date was February 2015. Germination started after seven days of seed sowing. Eighty five percent seeds were germinated. After fifteen days of germination, virus symptoms were exhibited on seedlings. Virus symptom was dominated with the increasing of seedlings age. However, the minimum virus incidence was recorded in non-infected seed with net covered and the maximum was recorded in infected seed without net covered.

Use of tricho-products for soil borne disease management in cabbage production

The experiment was conducted in seed bed nursery and main field with cabbage (variety Atlas 70) at HRC, BARI, Gazipur to control soil borne pathogen by using Tricho-products. In seed bed nursery application of Tricho-compost @ 1.5 t/ha+ Tricho-spore @ 100 ml/m^2 increased fresh and dry weight of seedling and reduced mortality of seedling. In main field, wilting disease caused by *Fusarium* sp. was lower in Tricho-compost and talc base *Trichoderma* application treatments. Both Tricho-compost and talc base *Trichoderma* alone with foliar spray of Tricho-leachate reduced 60.29 % and 61.91% wilting, respectively. Length and diameter of head of cabbage increased due to Tricho-products application. Marketable yield increased in Tricho-compost and talc base *Trichodrma* applied fields. Each of Tricho-compost and talc base *Trichoderma* with foliar spray of Tricho-leachate increased 20.13 % and 20.06% yield, respectively over untreated control.

Control of seed borne disease of brinjal using heat, biogent and chemical treatment

The effect of hot water 50 °C of 25 min heat treatment, *Trichoderma* and Bavistin on seed mycoflora, germination and vigour index of brinjal was evaluated. The seed treatments improved seed germination, vigour index and reducing seed borne mycoflora of brinjal seeds. A total of five fungal species were isolated from brinjal seeds. Isolated fungi were identified as *Aspergillus flavus*, *Aspergillus niger*, *Curvularia* spp, *Phomopsis vexans* and *Fusarium* spp by blotter and PDA media. Among them *Phomopsis vexans* and *Fusarium* spp were the most dominant pathogen observed on treated and untreated seeds of brinjal. It was effectively controlled in the treatment of *Trichoderma* and Bavistin fungicide. The highest seed germination was observed in Provax (43.29) followed by Bavistin (34.48) and hot water (35.48) whereas the lowest in control (20.16) treatment. The highest incidence percentage of mycoflora (20%) was recorded in control treatment whereas it was lowest in Bavistin and Provax (3%). Provax and Bavistin treated seeds showed beneficial effects on germination which resulted in increased root-shoot length and seedling vigour. Vigour Index was the maximum in the treatment of Provax (193.97) and Bavistin (164.46) followed by *Trichoderm*a (121.88) and the lowest recoded in control (71.68). In both consideration of vigour index and mycoflora percentage Provax and Bavistin performed better followed by *Trichoderma* and hot water.

Management of TYLCV through chemical and cultural means

An experiment was conducted at plant pathology Section, HRC, BARI during winter 2014-15 cropping season to select a suitable management practice against tomato yellow leaf curl virus disease. BARI tomato 8 variety was used in this 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. The highest incidence (59.26%) of disease was observed in control plots whereas it was the lowest (12.29%) in yellow plastic mulch followed by (19.70%) in straw mulch and (33.33%) in barrier crops treatments. The highest yield (20.80 kg/plot) was recorded in straw mulch and the lowest yield (13.63kg/plot) was recorded in control plot. Among the four treatments for TYLCV in tomato, polythene mulch and straw mulch were effective to control the disease.

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 Jessore project site, pointed gourd, bottle gourd, country bean, cauliflower, cabbage and brinjal were cultivated by six, two, one, four, four and three farmers, respectively by using Tricho-products. While in Bogra project site, pointed gourd, country bean, cauliflower, cabbage, brinjal and tomato were produced by five, three, five, three and one farmers, respectively. Application of Tricho-compost and -leachate reduced *Phytophthora* fruit rot by 54.98 and 68.13%, and increased marketable yield by 30.69% and 49.76% in pointed gourd at Jessore and Bogra, respectively. Due to application of Tricho-products, anthracnose fruit rot disease caused by *Colletotrichum* sp. was reduced by 44.63% and 53.57% in bottle gourd and in summer country crops, respectively at Jessore. While in winter country bean it reduced anthracnose disease by 51.96% at Bogra. *Fusarium* wilt was reduced 77.59% and 84.88% in Jessore and Bogra, respectively in cauliflower crops due soil incorporation of Tricho-compost. *Alternaria* leaf spot disease of cabbage was reduced about 55.0%. While in Brinjal crop, bacterial wilt was reduced by 82.5% and 20.25% in Jessore and Bogra, respectively. Yield increased by 24.16%, 25.11%, 19.30% and 15.66% in bottle gourd and summer country bean, cauliflower, cabbage, respectively at Jessore project site. In Bogra project site, winter country bean, cauliflower and cabbage yield increased by 18.07%, 15.43% and 8.35%, respectively. Yield increased in Brinjal by 26.23 and 20.25% at Jessore and Bogra, respectively. Benefit Cost Ratio was increased in different vegetable crops range from 17.11 to 45.12% regardless of locations.

Pest Control

Development of effective management package against thrips in brinjal

A study on development of an effective management package against thrips (Thripspalmi), a devastating pest of brinjal was conducted at Entomological Research Field of Horticulture Research Centre, BARI, Gazipur, during rabi season (October 2014 April 2015) with BARI Begun 8 to develop an effective management option against thrips. Six treatments, viz. T_1 = Use of white sticky trap, T_2 = Spraying of spinosad 45 SC (Tracer) @ 0.4ml/L of water at 7days interval, T_3 = Spraying of Bioneem plus (Azadirachtin 1EC) @ 1ml/L of water at 7 days interval, T_4 = Spraying of (Chlorphenapyr) Intrepid 10EC @ 1ml/L of water at 7 days interval, T_5 = Spraying of Fipronil (Aronil 50SC) @ 0.5ml/L of water at 7 days interval, and T_6 = Untreated control, in RCB Design with four replications. Considering marketable yield, benefit cost ratio, fruit infestation and fruit infestation reduction over untreated control spraying with Tracer @ 0.4ml/L and Aronil 50SC @ 0.5ml/L at seven days interval gave the maximum protection against thrips in brinjal.

Screening of country bean lines against pod borer

A study on screening of country bean lines/varieties against pod borer was carried out at Plant Genetic Resource Centre (PGRC) of BARI, Gazipur during rabi 2014-15 cropping season. A total of 50 country bean lines along with BARI released country bean variety BARI Sheem 7 were included in this program. Among 50 country bean lines 35 lines received no infestation by pod borer. Among 15 lines, no lines were found tolerant to pod borer. Lines RISA 116 and RISA 135 found moderately tolerant (MT), AR 43 and RISA 73 found moderately susceptible (MS) and rest of the lines found susceptible (S) and only line RISA 139 found very susceptible (VS) to pod borer.

Relative susceptibility of six country bean variety against aphids and pod borer

A study was carried out at Entomological Research Field of Horticultural Research Centre of BARI, Gazipur during rabi 2014-15 cropping season. Six BARI released country bean varieties viz., BARI Seem 1, BARI Seem 2, BARI Seem 3, BARI Seem 4, BARI Seem 5 and BARI Seem 6 were included in this study in a randomized complete block design. Different BARI released country bean varieties showed variable susceptibility to aphid. Aphid infestation was recorded nil in BARI Seem 4 and BARI

Seem 5 and ranked as tolerant. BARI Seem 1 and BARI Seem 6 ranked as moderately susceptible, BARI Seem 3 ranked as susceptible and BARI Seem 2 ranked as very susceptible to aphid. Similar susceptibility grading was also evident in case of percentage of twig infestation. Variable susceptibility was also evident in case of pod borer. Mean number of pod borer larvae per pod was recorded the lowest (0.33, 0.43 and 0.44) *in BARI Seem 6, BARI Seem 2 and BARI Seem 3, respectively and ranked as* moderately tolerant. BARI Seem 4 (0.81 larvae/pod) ranked as moderately susceptible. BARI Seem 1 (1.67 larvae/pod) and BARI Seem 5 (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.

Relative susceptibility of BARI released tomato varieties to fruit borer, leaf miner and white fly

The study was carried out at Entomological Research Field of Horticultural Research Centre of BARI, Gazipur during rabi 2014-15 cropping season. A total of six BARI released tomato varieties were re-screened for the above mentioned insect pests in a RCB designed plots with four replications. Mean number of fruit borer larvae recorded the highest 4.05 in BARI Tomato 2 and the lowest 1.80 in BARI Tomato 15. These were 2.20-3.10 in rest of the tomato varieties under study. In case of leaf miner, mean number of leaf miner larvae was recorded the highest 2.75/leaf in BARI Tomato 3 and the lowest in BARI Tomato 14. These were 2.20-3.10 in rest of the tomato varieties under study. Considering mean number of white fly, it was recorded the highest 2.70 fly/leaf in BARI Tomato 9 and the lowest in BARI Tomato 1.67 fly/leaf. These were 1.70-2.60 in rest of the tomato varieties under study.

Estimation of infestation on different crops in hydroponic culture

A study was conducted in hydroponic glasshouse and poly-tunnel shade at Horticulture Research Centre of BARI, Gazipur during April-September 2014 and October 2014 t0 March 2015 for both summer and winter seasons. In summer (April to September 2014), five crops viz. bitter gourd, capcicum, summer tomato, green-chili and netted melon was monitored for damage severity by insect pests. In winter (October 2014 to March 2015), five crops viz. bottle gourd, capsicum, tomato, cucumber and strawberry was monitored for damage severity by insect pests. Based on the damage percentage, the infestation percentage was high in netted melon by fruit fly and low in green-chilli by mite in summer. On the other hand, infestation was high in netted melon by fruit fly and low in green-chilli by mite. Rest of the infestation was medium. No crop is beyond infestation even under protective culture. Infestation may reach up to 79.17% if no control measure is taken. Necessary protection should be taken for successful cultivation in hydroponic culture.

Soil and water management

Development of USG-based fertilizer recommendation for yield and quality of broccoli

The experiment was conducted at the experimental field of Horticulture Research Centre, BARI, Joydebpur and RARS, Akbarpur, Moulvibazar during 2013-14 and 2014-15 on broccoli (cv. Premium Crop) to test the comparative performance of different fertilizer management packages on broccoli production and to select the best fertilizer management package(s) to develop a fertilizer recommendation for quality broccoli production. The experiment was carried out in RCBD with three replications. Eight treatments of different fertilizer doses were considered as : i) $N_{150}P_{50}K_{80}S_{30}Zn_5B_2Mo_1$ (N as PU) ; ii) $N_{150}P_{50}K_{80}S_{30}Zn_5B_2Mo_1$ (N as USG); iii) $N_{180}P_{53}K_{83}S_{20}Zn_2B_1Mo_{0.8}$ (N as PU); iv) $N_{146}P_{22}K_{62}S_{20}Zn_2B_1M_{0.8}$+3 ton PM (N as PU); v) $N_{126}P_{22}K_{62}S_{20}Zn_2B_1M_{0.8}$ + 3 ton PM (N as USG); vi) $N_{138}P_{46}K_{58}S_{20}Zn_2B_1M_{0.8}$+ 5 ton CD (N as USG); vii) $N_{..}P_{..}K_{..}S_{..}Zn_{..}B_{..}Mo_{..}$ (N as PU) (Soil test base) and viii) Native fertility (control). Among the different treatments, T_5 ($N_{126}P_{22}K_{62}S_{20}Zn_2B_1M_{0.8}$+ 3 ton PM, N as USG) were found better yielding (15.91-15.93 and 12.64-15.25 t/ha) for Joydebpur and Akbarpur, respectively followed by T_3 ($N_{180}P_{53}K_{83}S_{20}Zn_2B_1Mo_{0.8,}$ N as PU) with 13.63-15.04 and 10.35-14.55 t/ha for Joydebpur and

Akbarpur, respectively. In respect of economic profitability, the highest benefit-cost ratio (4.40-4.25 and 3.50-4.02) was obtained from T_5 ($N_{126}P_{22}K_{62}S_{20}Zn_2B_1M_{0.8}$+ 3 ton PM, N as USG) followed by T_3 ($N_{180}P_{53}K_{83}S_{20}Zn_2B_1Mo_{0.8}$ (N as PU) with the BCR 3.91- 4.12 and 2.97-3.93, respectively. The results suggested that fertilizer package T_5 with USG and 3 ton poultry manure and T_3 ($N_{180}P_{53}K_{83}S_{20}Zn_2B_1Mo_{0.8}$ (N as PU) could be recommended as an effective fertilizer packages for quality broccoli production for these area.

Effect of NPKS fertilizer management on the growth and yield of carrot

A study on effect of NPKS nutrient management for carrot was conducted at HRC, BARI, Joydebpur and ARS, Burirhat, Rangpur during winter season of 2012-13 to 32014-15. The variety R.K-555 (F_1 Hybrid) was used in the study. The experiment was laid out in RCB design with three replications. The study comprised of 14 treatments combination. The treatments differed significantly for their response to yield contributing characters. The maximum average root weight (164.7 g and 146.6 g) was obtained from T_3= $N_{120}P_{40}K_{80}S_{20}$ and T_7=$N_{120}P_{60}K_{80}S_{20}$ (kg/ha) for Joydebpur and Burirhat, respectively and the lowest was from T_{14} for both the location. The maximum dry matter of root (13.47%) was obtained from T_7 at Burirhat. The treatment T_7=$N_{120}P_{60}K_{80}S_{20}$ (kg/ha) gave the maximum root length (14.47cm and 17cm) and diameter (4.193cm and 43.29 mm) and the lowest length (12.40cm and 11.83mm) and diameter (3.53cm and 27.03mm) were recorded from T_{14} for Joydebpur and Burirhat, respectively. The highest root yield per hectare (28.59 t/ha and 32.31 t/ha) was recorded from the treatment T_3=$N_{120}P_{40}K_{80}S_{20}$ and T_7=$N_{120}P_{60}K_{80}S_{20}$ (kg/ha) for Joydebpur and Burirhat, respectively while the minimum yield (13.33 t/ha and 13.62 t/ha) was obtained from control (T_{14}) for both the location. After three years study, we could be recommended T_3 ($N_{120}P_{40}K_{80}S_{20}$ kg/ha) and T_7 ($N_{120}P_{60}K_{80}S_{20}$ kg/ha) as the most productive fertilizer dose for better yield and economic dosee for carrot production at Joydebpur and Burirhat, respectively.

Effect of vermicompost and cowdung on the yield of cucumber

An experiment was conducted at HRC, BARI, Joydebpur during 2013 to2014 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). 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).

Response of broccoli to different irrigation regimes

The study was conducted at the experimental field of Horticulture Research Centre, BARI, Gazipur during 2012-13 to 2014-15 to investigate the response of broccoli (cv. Premium) under different irrigation regimes. The experiment was carried out in RCBD with four treatments and five replications. The treatments were: I_1=Irrigation up to FC at 5 days interval after plant establishment (PE), I_2= Irrigation up to FC at 10 days interval after PE, I_3 = Irrigation up to FC at 15 days interval after PE and I_4= Irrigation up to FC at 20 days interval after PE. A significant response of broccoli to different irrigation levels was observed. Among the different treatments, I_2 (irrigation at 10 days interval) were relatively better yielding (19.98 t/ha in the first and 20.63 t/ha in the second year). The lowest yields were observed from the treatment I_4 in both the years. The highest (382.30 mm in the first and 296.58 mm in the second year) seasonal water were used in treatment I_1 and lowest (204.60 mm in the first and 185.66 in the second year) were found in treatment I_4 and I_3, respectively. The results suggest that irrigation at 10 days interval (I_2) might be optimum irrigation schedule for broccoli production on the basis of gross return. But in respect of economic profitability, the highest marginal rate of return is obtained from treatment I_3.

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 evaluate the efficiency of USG in combination with or without B and Mo on cauliflower production to evaluate the response of cauliflower to micronutrients on quality cauliflower production and to develop an USG based optimum and economic doses 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. Lower yield was resulted where B and Mo were not used than in recommended USG with these micronutrients. The maximum curd yield was recorded in T_1 (30.494 t/ha) treatment followed by T_4 (30.247 t/ha). But in the economic point of view 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 (4.21).

Development of USG based fertilizer recommendation for bitter gourd

An experiment was conducted at HRC, BARI, Joydebpur during 2014 to 2015 on bitter gourd to 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 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. 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 (20.4 and 21.119 t/ha) with maximum gross return of Tk. 408000 and 422380/ha, respectively for the years 2014 and 2015 and economic profitability. Treatment T_3 also showed the satisfactory yield and economic benefit.

Post harvest management

Observation of different combination of ready-to-cook vegetables

An experiment was conducted to select suitable additives for preparing ready to cook cabbage and cauliflower. It was done in the laboratory of Postharvest Technology Section, Horticulture Research Centre, BARI, Gazipur during January 2015. Ready to cook cauliflower and cabbage 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±1ºC). Cabbage treated with 0.5% citric acid (T_2) and cauliflower without any additives (T_0) showed better shelf life 7 days over all treatments retaining better color, titratable acidity (%), vitamin C and sensory quality stored at refrigerator (4±1ºC).

Effect of cling film wrapping on extending the shelf life of cauliflower

Medium sized cauliflower (*Brassica oleracea* var. botrytis) curds after removing outer leaves, sorting and without washing were packed in different packaging techniques and stored at normal refrigerator (6±1°C and 50±5% RH) and at ambient condition (25±3°C and 60±5% RH). Changes in curd respiration rate, colour, texture, weight, decay quality, shelf life and some chemical parameters like ascorbic acid, acidity, TSS, were evaluated during storage period. Cauliflower curds wrapped with PE cling film or packed in LDPE bag (1% perforation) stored at refrigerator (6±1°C and 50±5% RH) could retain white colour, good sensory quality, firm and fresh curds with minimum loss in weight, texture and spoilage up to 16 days for LDPE packed and 18 days for cling film wrapded curds.

Evaluation of postharvest quality of tomatoes for selecting long shelf life lines

The effect of varietal characteristics on ripening and postharvest quality of tomato fruit (*Solanun lycopersicum* L.) of nine tomato lines namely CLN3940, CLN3946, CLN3947, CLN3948, CLN3949, CLN3953, CLN 3954, CLN3961 and Tanya supplied by AVRDC was investigated at Horticulture Research Centre, BARI, Gazipur, Bangladesh during October 2014 to March 2015. Tomato variety ‘BARI tomato 14’ was used as a check in this experiment. Fruits were harvested at breaker-turning stage and brought to the postharvest laboratory. After that the fruits were transferred to the storage for three weeks at ambient conditions (22-27 °C and 63-75 RH). Tomato fruits of different lines suffered different levels of shriveling and rot development, which ranged from 28 to 73.3% and 0 to 8.3%, respectively at the end of 20 days of storage. No rotting symptom was observed in tomatoes of BARI Tomao 14, CLN3948, CLN3949, CLN3953 and CLN3954 lines even at the end of 20 days of storage. The rate of physiological weight loss (PWL) also varied significantly (P<0.05) among the lines. BARI Tomato 14 and CLN3948 exhibited the lowest PWL (≈11.4%) by the end of 20 days storage. The lowest reduction in hue angle was observed in the tomatoes of CLN3946, CLN3947 and CLN3949 lines and finally preserved the highest value represents 53.2° at 20 days of storage. Changes in tissue firmness of fruits of CLN3948 line significantly delayed and secured the maximum value of 0.66 kg at the end of 20 days of storage. The TSS and P^H values were not changed significantly during storage period. The tomatoes of CLN 3948 and CLN 3949 lines showed the maximum shelf life of 20 days whereas, only 10 days shelf life was found in tomatoes of BARI Tomato 14, Tanya and CLN 3961 lines. Based on the PWL, tissue firmness, resistance to rotting and shriveling, surface colour change and shelf life, CLN3948 and CLN3949 may be considered for long shelf life tomato lines for further evaluation.

Determination of maturity indices of BARI Tomato 14

The choice of fruit picking time plays a key role in quality and shelf life of tomato fruits. In order to determine the influence of different maturity stages on tomato fruit quality, a trial was carried out with popular tomto variety BARI Tomato-14. Six stages of maturity were considered as treatment. Fruit weight and size gradually increased with the maturity stages advanced. The highest yield was obtained from premature green stage and the lowest from ripe stage. Fruits of ripe stage required 55 days from anthesis. Fruits of mature green and premature green showed the maximum firmness. The highest DA value was found in immature green tomato and the lowest value was found in ripe tomato. Mature green stage contained the maximum amount of Vit. C. Acidity decreased and TSS increased with advancement of maturity.

Quality and marketable life of tomato as affected by postharvest treatment, modified atmospheric packaging and storage condition

An experiment was conducted at Horticulture Research Centre, BARI to evaluate the effectiveness of sanitizing treatment, modified atmospheric packaging and storage condition on the quality and marketable life of tomato. BARI Tomato 14 was grown in the field of HRC and harvested at breaker-turning stage in March 2015. The harvested fruits were subjected to postharvest treatments i.e. dipping in aqueous cold and normal calcinated calcium (CCa), cold water and normal water for seven minutes. The pre-cooling sanitizing of tomato was achieved with crushed ice to 10°C to bring down product temperature to 13-15 °C. The treated fruits were dried with table fan and packed with and without 0.05 % perforated polyethylene bag inside plastic crate and kept in ambient condition or Evaporative cool chamber (ECC) which was designed and fabricated on the principle of evaporative cooling. The temperature and relative humidity for ambient condition and ECC were noted during the storage period. Data were recorded on weight loss, firmness, colorimetric traits, biochemical qualities and storage life of the treated tomatoes. The cool chamber reduced temperature from 0.6°C to 2.4°C, 3.0 °C to 7.2 °C and 5.4^{0}C to 7.0^{0}C at morning (6:30am), noon (1:30pm) and evening (6:30pm), respectively. It increased relative humidity from 17% to 29%, 24% to 34% and 18% to 32% at morning (6:30am), noon (1:30pm) and evening (6:30pm), respectively. The weight losses of tomato were statistically different both for postharvest sanitation and packaging treatments. Inside the ECC, it was recorded 0.001%, 052%, 1.22%, 1.52% and 1.78% after 3, 6, 9, 12 and 15 days of storage, respectively. On the mentioned days, it was computed as 1.38%, 3.29%, 5.37%, 10.76% and 13.60% outside the ECC. The firmness was higher inside the cool chamber. The lightness and hue angle was almost similar among the different treatments. There was no single treatment which had higher TSS (%) and pH throughout the storage period. Tomatoes stored in ECC retained significantly higher vitamin C content throughout the whole storage period and at the end of 15 days storage it was recorded 15.38 mg $100g^{-1}$ compared to ambient storage showing value 13.82 mg $100g^{-1}$. The mean marketable life of tomato was found higher (13.49 days) inside evaporative cool chamber. It was only 7.75 days at ambient condition. Tomato treated with CCa sanitizer and kept openly in plastic crate inside ECC had the highest marketable life, recorded as 15 days.

Quality and marketable life of yard long bean as affected by maturity and packaging

An experiment was conducted to evaluate the effect of maturity and packaging on the quality and marketable life of yard long bean during April to July 2014. The variety, BARI Yard long 1 was raised in the research field of HRC, BARI. The pods were harvested 10, 12, and 14 days after anthesis and carried to laboratory for packaging and storage study at ambient condition. Data regarding physical characters, physiological loss in weight, biochemical characteristics, quality criteria, marketability and marketable life were recorded during the study period. The good quality yard long bean pods were obtained from the maturity stage, designated as M_1 and M_2 i.e. by harvesting pods at 10 and 12 days after anthesis. At this stage, the pods of BARI Yard long bean-1 attained a size of 45.13-49.24 cm length and 5.04-5.79 mm diameter with an average weight of 11.09-16.00g weight. The pods of the stage M_1 and M_2 retained marketable life 74.00 and 64.00 hrs., respectively. The pods of the stage M_3 had the mean marketable life only 50.00 hrs. Though the modified atmospheric packaging minimized weight loss of yard long beans, they had no enthusiastic effect to extend marketable life at ambient condition. The highest marketable life (78.00 hrs.) was obtained from the pods harvested 10 days after anthesis and packed in 1.0% perforated polyethylene bag. It was the lowest (48.00 hrs.) for the pods harvested 14 days after anthesis and kept without packaging at ambient condition.

Agriculture Economics

Economics of brinjal cultivation and its adoption status in most vegetables growing areas of Bangladesh

The study was conducted in six districts of Bangladesh among 300 farmers by taking 50 farmers each district. Profitability, adoption and opportunities to brinjal cultivation were identified factor share and productivity models were used to fulfill the objectives of the study. About 66 percent farmers were literate and agriculture was the main occupation among the farmers. Most of the farmers were trained in brinjal cultivation and age below 40 years. The farmers cultivated BARI Begun-9, 8, 7 varieties in these areas. Department of Agriculture Extension and Bangladesh Agricultural Research Institute was the main information provider to the farmers. The farmers cultivated brinjal in summer and winter season. Farmers did not follow the standard plant spacing in the areas. Norsingdi and Jessore farmers incurred higher costs Tk 463680 and Tk 395890 and got returns Tk 1159200 and Tk 1088700, respectively. Insecticides and pesticides had the highest factor share 15 to 24 percent of total share and land use cost occupied the lowest share of factors. Adulteration in pesticides, shoot and fruit borer, foot and root disease etc. were the main constraints to cultivate brinjal in the study areas like all over Bangladesh.

7 FRUIT CROPS

Varietal Development

Evaluation of jackfruit germplasm

Twenty jackfruit germplasm were evaluated in the Fruit Research Farm of HRC, BARI, Gazipur during the fruiting season of 2014-15. Wide range of diversity was observed in plant height, trunk height, plant spreading, number of fruits per plant, fruit and pulp characters of jackfruit. Plant height varied from 4.30 to 7.15 m and trunk height from 50 to 92 cm. Great variation in number of fruit (2 to 30) was also observed. Fruit characteristics of jackfruit germplasm also varied largely. The fruit weight ranged from 2.69 to 11.51 kg. Number of bulbs per fruit varied from 41 to 205. TSS was noticed to vary from 15.0 to 29.0 ^{o}Brix. In respect of number of fruit, fruit weight, edible portion, TSS and pulp quality, the germplasm AH Joy-059-1, AH Joy-063-3, AH Joy-067-3 and AH Joy-073-2 were found promising.

Evaluation of existing jackfruit germplasm

Ten germplasm of existing jackfruit were evaluated at ARS, Burirhat, Rangpur during 2013-14. The results revealed that the germplasm AH Bur-001 showed better performance in respect of earliness, fruit size, yield and quality among other germplasm. The age of the trees ranged from 17 to 82 years and plant height from 13.0 to 16.2 m.The germplasm AH Bur-005 gave the highest plant height (16.20 m) and AH Bur-004 the lowest (13.00 m). Base girth varied from 1.9 to 4.2 m. Maximum base girth was recorded in AH Bur-009 (4.2 m) and minimum in AH Bur-004(1.9 m). In case of canopy spread, maximum canopy in East-West was obtained from AH Bur-009 (19.5 m) and minimum from AH Bur-002 (8.1 m). Similarly, in case of North-South, the canopy spread was maximum in AH Bur-009 (20.85 m) and minimum in AH Bur-003 (12.5 m). Flowering time also varied from 4th week of January to 3rd week of February. The time of harvesting was within 4th week of May to 2nd week of July. The fruits of germplasm AH Bur-001 were harvested in 4th week of May while the fruits of germplasm AH Bur-008 were harvested in 2nd week of July. The germplasm AH Bur-001 was found as the best performer in terms of earliness, fruit size, yield and quality.

Collection and evaluation of jackfruit germplasm

Twenty three Jackfruit germplasm were evaluated at Jamalpur region during the year 2013-2014. Germplasm were selected as 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 to identify superior jackfruit germplasm. Four fruits from each plant were randomly selected for evaluation. Fully matured fruits were harvested from the plant and data on different parameters like age of plant, total number of fruits per plant, date of harvest, weight of individual fruit, yield per plant, fruit length, fruit breadth, fruit shape, fruit color, weight of rind, weight of rachis, rind thickness, total number of bulbs per fruit, total bulb weight per fruit, bulb color, bulb or pulp firmness, taste of bulb, bulb length, bulb breadth, 10-bulb weight, total number of seeds per fruit, seed color, seed length, seed breadth, total seed weight per fruit, 10-seed weight, stalk attachment, % edible portion and % TSS were recorded. The highest fruit yield per plant (525.00 kg) was observed in AH Jam-12 and the lowest in AH Jam-16 (37.31 kg). Maximum TSS (%) was obtained from AH Jam-01 (23.50 %) and minimum from AH Jam-13 (12.50 %). The highest edible portion was obtained from AH Jam-19 (54.49 %) followed by AH Jam-02 (51.78 %) and the lowest from AH Jam-10 (13.02 %).

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 were found to be suitable for jackfruit cultivation at Jamalpur region.

Evaluation of superior jackfruit lines

The study was conducted at Citrus Research Station, Jaintapur, Sylhet from Decembe-2013 to August 2014. Five jackfruit lines were selected for the study. A wide variability was observed in different parameters such as weight of fruit, number of fruits/tree, size of fruit, shape of fruit, number of bulbs in a fruit, percent edible portion and percent TSS among the germplasm studied. The germplasm AH Jai-078 was observed to be superior with the highest number of fruits (180) per plant followed by AH Jai-005 (155). Among the germplasm fruits of AH Jai-078 were harvested in early March which was considerably early in the fruiting season. It also retains fruit up to the end of the season creating a longer harvesting period. The highest edible portion was found in AH Jai-095 (50.94%) whereas the lowest in AH Jai-005 (32.49%). Maximum per cent TSS (23.17%) was found in AH Jai-005 whereas minimum in AH Jai-095 (18.33%).

Evaluation of exotic mango germplasm

An experiment was conducted on the evaluation of five exotic mango germplasm (MI Ex-001, MI Ex-002, MI Ex-003, MI Ex- 004 and MI Ex-005) at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur during 2014-15. Germplasm MI Ex-005 and MI Ex-003 had maximum (4.65 m) and minimum (3.67 m) plant height, respectively. MI Ex-003 showed the highest tree volume (68.50 m^3), followed by MI Ex-001, while the lowest value was observed in MI Ex-002 (61.07 m^3). The highest canopy spread (5.55 m) at North-South was found in MI- Ex 001 and the minimum canopy spread (3.25) was found in MI- Ex 002. Full bloom took place from early January to late February, where MI Ex-001 was the earliest and MI Ex-005 was the latest. MI Ex-005 produced maximum number of fruits per tree (138), while it was noted minimum in MI Ex-002 (12). Fruit harvesting period ranged from 1st week of June 2015 to 1st week of July 2015, where MI Ex-005 was the earliest and MI Ex-002 was the latest fruit producing germplasm. Maximum fruit weight was recorded in MI Ex-003 (452 g) and minimum was recorded in MI Ex-005 (158 g). Total Soluble Solids was noted the highest in MI Ex-1 (18.33%) which was statistically similar to that of MI Ex-002 (18.33%), while the lowest TSS (13.67 %) was found in MI Ex-003 and MI Ex-005. The highest infestation of leaf cutting weevil was found in MI EX- 005 (9.00%), as against the lowest in MI EX - 001 (1.25%). Among the germplasm, MI Ex-001 was the most susceptible germplasm showing 5.12% vegetative malformation. Only fruits of MI Ex- 002 were infected by anthracnose. Maximum fruit cracking was observed in MI Ex-002 (14.21%). The overall growth condition of all the germplasm was satisfactory. Considering yield and quality MI Ex-001, MI Ex-002, MI Ex-003 were found promising.

Phenological growth patterns of mango varieties under central region of Bangladesh

Phenological responses were studied on five mango cultivars viz. BARI Mango 1, BARI Mango 3, BARI Mango-4, Langra and Fazli at Fruit Research Farm of HRC, BARI, Gazipur. The result revealed that plants of BARI Mango 4 were prompt in primary vegetative flushing while BARI Mango-3 was found late. Number of new buds per shoot varied significantly and the highest number of new buds were found in BARI Mango 3 (2.00) followed by BARI Mango 1 (1.50) and Langra (1.15), while the BARI Mango 4 produced the lowest buds/shoot (0.95). The Langra required maximum days for the completion of primary vegetative flushing (120 days) and BARI Mango 3 required minimum (59 days). Number of new leaves per shoot also varied significantly and among the varieties it ranged from 10.75 to 7.60. Among the mango varieties BARI Mango 1 took the shortage period (223 days) from vegetative flushing to inflorescence opening, while Langra required longer period (253 days). Days to fruit set to inflorescence opening was found wider in BARI Mango 4 (27 days)and that of shorter in Langra (16 days). The maximum days to harvest from fruit set was observed in BARI Mango 4 (150 days).

Collection and evaluation of some coloured mango germplasm

An experiment on collection and evaluation of 36 coloured mango germplasm was conducted at the Regional Horticulture Research Station, Chapainawabganj during 2014-15. Germplasm were collected from different places of Rajshahi and Chapainawabganj district and found superior regarding colour in mango show, 2008. A wide variation was observed among the germplasm regarding growth and tree characteristics. All the germplasm produced panicles and out of these 21 germplasm produced fruits in this year. A significant variability was observed among the germplasm regarding inflorescence characteristics like panicle length, colour, shape, percent hermaphrodite flowers and fruit set. The 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) was recorded in MI Cha-011. Fruit size including length, breadth and thickness varied significantly among the germplasm. MI Cha-020 was obtained maximum edible portion (86.46%) while the minimum of 53.84 under 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 36 germplasm, 19 produced fruits but 17 did not this year. 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 considering qualitative characters like colour, TSS, shelf life and fruit attractiveness.

Inter-varietal hybridization of mango

A hybridization programme was conducted in the flowering seasons of 2015 at RHRS, Chapai Nawabganj. A total of 4,508 flowers from 828 panicles were emasculated and pollinated. Twenty two hybrid fruits were obtained from different crosses. Two hybrid fruits from the cross Khirsapat x Palmer, 1 hybrid fruit from the cross Langra x Palmer, 8 hybrid fruits from the cross BARI Aam 3 x Palmer, 3 hybrid fruits from the cross Fazli x BARI Aam 3 and 8 hybrid fruits of Ashwina x Palmer. These mango hybrid fruits were harvested at mature stage and stones of the fruits were planted in soil for germination in the hybrid seedling plot. After germination, these one year hybrid seedlings will be transplanted in the main field after khasi and will be evaluated in the following season.

Inter-varietal hybridization of mango (set-ii)

A hybridization programme was conducted in the flowering seasons of 2015 at RHRS, Chapai Nawabganj. The existing mango germplasm of RHRS were used as parental combinations of crosses. A total of 436 flowers from 74 panicles were emasculated and pollinated. Ten hybrid fruits were obtained from different crosses. One hybrid fruit from the cross Mixed special x Langra, 2 hybrid fruits from the cross Mixed special x Fazli, 4 hybrid fruits from the cross Mixed special x Ashwina and 3 hybrid fruits from the cross Mixed special x SOM-1048. These mango hybrid fruits will be harvested at mature stage if retained finally and stones of the fruits will be planted in soil for germination in the hybrid seedling plot. After germination, these one year hybrid seedlings will be transplanted in the main field after khasi and will be evaluated in the following seasons.

Performance of SOM-1048 mango germplasm

An experiment on performance of SOM-1048 mango germplasm was carried out at RHRS, Chapai Nawabgonj during the fruiting season of 2014 to know whether the SOM-1048 mango germplasm as a late superior variety or not. The original plant of SOM-1048 mango germplasm selected through survey from Chapai Nawabgonj district in 2002. Then the scions were collected from selected plants and grafted on rootstocks at the nursery of RHRS, Chapai Nawabgonj. Tree volume 38.27 m^3 was recorded in the SOM-1048. Fruit weight (550.00 g), fruit yield (37.26 kg), and edible portion (85.45%) and TSS (18.00 %) were recorded. Fruit fly infestation was recorded (20.10%)at the time of harvest. SOM-1048 was found 23% disease incidence of anthracnose and stem end rot was absent. Shelf life was found to be 7-8 days.

Performance of some mango hybrids

An experiment on performance of mango hybrids was carried out with 2 mango hybrids namely Hy-089 and Hy-090 at RHRS, Chapai Nawabgonj during the fruiting season of 2015 to know the detailed information on plant growth, fruit characteristics and yield. Between the two mango hybrids, the maximum tree volume was recorded in Hy-090 (15.98 m^3) and the minimum was recorded in Hy-089(13.57 m^3). Fruit weight was maximum in Hybrid-090 (306.0 g) while the minimum in Hybrid-089 (283.0 g). The highest yield of fruit was recorded in Hy-089 (17.06 kg) while the lowest in Hy-089 (3.67 kg). Hy-089 had maximum edible portion (72.79%) whereas minimum was in Hy-090 (68.95 %). The highest TSS (21.0 %) was recorded in Hy-090 while minimum (15.0%) was in Hy-089. The hhighest fruit fly infestation at the time of harvest was recorded in Hy-090 (55.00 %) while the lowest Hy-089(35.0%). The mango hybrid Hy-090 showed the highest incidence (45%) while the lowest was found in Hy-089(32.0%). Stem end rot was absent in both the mango hybrids. Shelf life was found in both the mango hybrids for 5-6 days. Considering overall performance of yield, number of fruits, fruit weight and even percent edible portion, colour, eating quality and total soluble solids (TSS) none of the hybrids were superior.

Performance of BARI released mango varieties in Chittagong Hill Tracts

An experiment was conducted on the existing 7 year old mango orchard containing BARI Aam 1, BARI Aam 2, BARI Aam 3, BARI Aam 4 and BARI Aam 8 at hill valley of Hill Agricultural Research Station of Raikhali in Rangamati Hill district during 2014-15. The maximum plant height (576 cm), base girth (75 cm), number of fruits per plant (425.3), fruit length (12.5 cm) and yield (44.1 t/ha) were observed in BARI Aam 8. The lowest number of fruits per plant (153.0), edible portion (71.6%) and fruit yield (6.3 t/ha) were found in BARI Aam 1. The heaviest fruit (443.7 g) and the highest edible portion (81.2%) were found in BARI Aam 4. The maximum TSS (16.7%) was recorded in BARI Aam 3 and the minimum (13.0%) in BARI Aam 2. Based on number of fruits per plant and fruit yield with the higher TSS, individual fruit weight, fruit volume, edible portion BARI Aam 8 and BARI Aam 4 were superior among all other varieties under study in Chittagong Hill Tracts (CHT). Though, BARI Aam 2 and BARI Aam 3 were found to be promising for their satisfactory yield in CHT. BARI Aam 1 was suggested as suitable early variety.

Clonal selection of mango cv. Harivanga

The experiment was carried out at RARS, Burirhat, Rangpur during 2014-15. Twenty four Harivanga germplasm were selected from 24 orchards. Among 24 germplasm only 5 germplasm gave flowering in this season. The age of the tree ranged from 8 to 24 years. Five fruits of each germplasm were collected at the maturity stage. Data were recorded on different characters of the fruits. The results revealed that the germplasm MI Hari-Bur-004 was better in respect of average fruit weight (317.20 g), percentage of TSS (18.5%), edible portion (72.70%) and fruit bearing (65%).

***In situ* evaluation of selected coloured mango germplasm**

Four coloured mango germplasm namely MI C-Bur-001, MI C-Bur-002, MI C-Bur-003 and MI C-Bur-004 were selected for the study during 2014-15 at RARS, Burirhat, Rangpur during 2014-15. Five ripe fruits were taken from the selected germplasm for recording the data on different parameters.

Considering the parameters TSS like (22.33%), edible portion (70.47%) and fruit bearing (70%), the germplasm MI C-Bur-001 was found the best.

In situ evaluation of selected local elite mango germplasm

The study was conducted at RARS, Burirhat, Rangpur during 2014-15. Four local elite mango germplasm namely MI Bur-007, MI Bur-008, MI Bur-009 and MI Bur-010 were selected from homestead and mango orchard of the farmer through survey and interview under Mithapukur Upazilla of Rangpur district. No flowering was observed in the germplasm MI Bur-008 and MI Bur-009 in this season. Five ripe fruits from the germplasm MI Bur-007 were taken for recording the data on different parameters. The germplasm showed over all better performance in respect of fruit weight (252 g), TSS (16.5%), edible portion (66.55%) and fruit bearing (50%).

Evaluation of superior mango germplasm

Four germplasm 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 during 2013-2014. One year old veneer grafts were planted in the field on July 2010 with a spacing of 8 X 8 m. A single tree of each germplasm constituted the unit of replication. The tallest plant (3.44 m) was observed in MI Pah-001 and the shortest (2.10 m) in MI Pah-002. Tree volume was maximum (20.11 m^3) in MI Pah-001 and it was minimum (8.99 m^3) in MI Pah-004. The earliest flowering was observed in MI Pah-001 and the latest in MI Pah-004. Earlier harvesting was achieved from MI Pah-001 on first week of May 2014 and the latest harvesting was achieved from MI Pah-004 on first week of June 2014. The heaviest fruit (393 g) was observed in MI Pah-003 followed by MI Pah-004 (347g) and the lightest fruit (163g) was observed in MI Pah-001. The maximum number of fruits (50.21) was observed in MI Pah-003 while the minimum fruits (29.50) in MI Pah-004. Highest edible portion (84.30 %) was achieved from MI Pah-003 and the lowest (65.72 %) from MI Pah-001. Maximum Total Soluble Solids (TSS) was observed in MI Pah-004 (19.6%) which is closely related to MI Pah-002 and MI Pah-003 (18.2% and 18.6%, respectively) and the minimum TSS (17.8%) was observed in MI Pah-001. The highest yield per tree (17.51 kg) was produced by MI Pah-003 and the lowest yield per tree (8.88 kg) was produced by MI Pah-001.

Performance of mango (Kacha mitha) germplasm at hilly region

An experiment was conducted to evaluate two mango (Kacha mitha) germplasm (MI Kha-001 and MI Kha-002) at the Hill Agricultural Research Station, Khagrachari during 2014-15. The maximum plant height was observed in MI Kha-001(6.20 m) and the minimum in MI Kha-002 (5.30 m). The highest canopy spread 5.80 m at North-South and 5.70 m at East-West were obtained from MI Kha-001. The full blooming period was the first week of January, 2015. The tree habit was spreading to intermediate type. Fruit harvesting period was 18-20 May, 2015. The highest number of fruits per plant was obtained from MI Kha-001 (294) and the lowest from MI Kha-002 (197). The maximum fruit weight was recorded in MI Kha-001 (257 g) and the minimum was recorded from MI Kha-002 (146 g). Total Soluble Solids (TSS) was noted the highest in MI Kha-001 (10.0%) and the lowest in MI Kha-002 (9.0%). Edible portion was found the highest in MI Kha-002 (73.28%) while the lowest was in MI Kha-001 (66.67%). Considering yield and quality MI Kha-001 was found promising to grow mango for using unripe condition. The experiment will be continued for final recommendation.

Performance of off season mango germplasm

An experiment was conducted to evaluate the off-season mango germplasm (MI Kha-Off-001 and MI Kha- Off-002 at the Hill Agricultural Research Station, Khagrachari during 2014-15. The germplasm MI Kha- Off-001 had the maximum plant height (3.50 m) and the minimum plant height (1.80m) was obtained in MI Kha- Off-002. The highest canopy spread 2.35 m at North-South and 2.45m at East-West was obtained from MI Kha- Off-001. The full blooming period was June, 14 and January, 15.

The tree habit was spreading type. Fruit harvesting period was December, 14 and May, 15 respectively. The highest fruits per plant were obtained from MI Kha- Off-001 (35) during January, 15 and the lowest in June, 14 (6) from MI Kha- Off-002. The Maximum individual fruit weight was recorded from MI Kha- Off-001 during June, 14 (460 g) and the minimum was recorded in June,14 flowering (95g) from MI Kha- Off-002. Total Soluble Solids (TSS) was noted the highest in MI Kha-Off-001 during June flowering (18.0%). Edible portion was found 66.61% in MI Kha- Off-001in June 14 flowering. The highest yield (18.48 kg) was obtained from MI Kha- Off-001 during January flowering while the lowest yield (0.38 kg) gave MI Kha-Off-002 during June flowering. Considering yield and quality MI Kha-Off-001 was found promising for off-season cultivation of mango at hilly region. The experiment will be continued for final recommendation.

Performance of some popular and BARI released mango varieties under high rainfall area of north eastern region of Bangladesh

The experiment was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet. Four commercial and 3 BARI released mango varieties, namely BARI Aam 1, BARI Aam 2, BARI Aam 3, Langra, Gopalbhog, Mollica and Kamala sinduri were included in the experiment. A wide variation was observed in case of growth and fruit characteristics. Highest plant height was observed in Mollica whereas BARI Aam 2 showed maximum base girth, canopy size, dense branching with excellent growth condition. The highest number of fruits/plant was found in BARI Aam 3 (92.00) while it was lowest in Mohonbhog (13.00). The highest fruit size was obtained from Mollica (13.5×8.43 cm) followed by BARI Aam 2 (9.63×8.37 cm) Maximum TSS (20.50%) was recorded from Gopalbhog. Maximum edible portion was found from Kamala sinduri (75.49%) followed by Gopalbhog (71.94%) while minimum was found from Langra (59.65%). Maximum yield was obtained from Molllica (6.26 t/ha) followed by BARI Aam 3 (4.3 t/ha) although fruit cracking was observed in Mollica variety. But BARI Aam 2 was exceptional retaining all the fruit without any cracking although its yield was lower compared to Mollica and BARI Aam 3. Considering all the parameters BARI Aam 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 some elite mango varieties in Patuakhali region

Twelve elite mango germplasm viz. BARI Aam 1, BARI Aam 2, BARI Aam 3, BARI Aam 4, BARI Aam 5, BARI Aam 8, Pahutan, Khirshapat, Langra, Mollika, Gopalvog and Fazli were planted in RHRS, Lebukhali, Dumki, Patuakhali to evaluate their adaptability in Patuakhali region in 2010. In fifth year, BARI Aam 3 produced the highest number of fruits (186) followed by BARI Aam 8 (96). BARI Aam 3, BARI Aam 4 and BARI Aam 8 showed better performance in Patuakhali region.

Evaluation of local mango germplasm

The experiment was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet with 21 mango germplasm. A wide variation was observed regarding plant height, base girth, spreading, number of fruits/plant, fruit weight, edible portion and TSS of different germplasm tested. From the study of first two years, 11 germplasm were selected for current year study. 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 fruit 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). Edible portion was 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.

Evaluation of exotic mango germplasm

An exotic mango germplasm (MI Raj-001) collected from Saudi Arabia was evaluated at Fruit Research Station, BARI, Binodpur, Rajshahi during 2014-2015. The Germplasm MI Raj- 001 had 3.6 m of plant height and 30 cm of base girth. The tree was intermediate type of habit. Average fruit weight was 560 g. Edible portion and TSS was 81% and 19%, respectively. Edible portion and TSS of BARI Aam 4 was 83% and 18%, respectively. Other characteristics were more or less similar on this germplasm. The plant produced 16 numbers of fruits in this year. Maturity time of fruit was 2nd week of July. The fruit had very attractive yellowish maroon colour at ripen. The growth condition and fruit characteristic of the germplasm was satisfactory.

Performance of mango germplasm at Jamalpur region

A study including some local and exotic genotypes of mango viz. BARI Aam 1,BARI Aam 3, BARI Aam 4, BARI Aam 5, BARI Aam 6, BARI Aam 8, Khirsapat, Ranipachand, Langra, Mollika, Fazli, Surjapuri, Harivanga, MI Jam-003, Baromashi, MI Jam-001and Nilambori was conducted at the Fruit Farm of HRC, RARS, Jamalpur during the fruiting season of 2014-2015. BARI Aam 3 produced the highest number of fruits (395) as compared to the least fruits (15) in MI Jam-003 and Nilambori. MI Jam-001 manifested the highest individual fruit weight (640 g). MI Jam-001 and Surjapuri exhibited the longest fruit (13.1 and 13.0 cm) compared to the shortest fruit in Baromashi (6.68 cm). BARI Aam 3 exhibited the best yield (70.0 kg/plant) as against the least yield 3.0 kg/plant in Nilambori. Ranipachand showed the highest TSS (21.0 %). MI Jam-001 had the highest shelf life (10 days) whereas Nilambori exhibited the lowest shelf life (5 days). The results revealed that BARI Aam 3, BARI Aam 8, Khirsapat, Ranipachand, Lagra, Mollika, Baromashi, and MI Jam-001 exhibited superior performances under Jamalpur condition.

Clonal selection of banana cv. Champa

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet during 2014-2015 with 11 Champa banana germplasm and BARI Kola 4 as check. A wide variation was observed regarding growth characteristics where MS Jai-008 was superior with 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), hands weight (0.9 kg), finger weight (40 g) was obtained from MS Jai-008 (10.8 kg). Yield was also maximum in MS Jai-008 (47.99 t/ha) with maximum sized finger (8.8×3.3 cm). Edible portion was higher in MS Jai-002 (87%). TSS was recorded 28% in MS Jai-002 and MS Jai-008 and 27% in BARI Kola 4.

Regional yield trial of banana lines

Six local and exotic banana genotypes were evaluated to identify/select the suitable variety and to know regional adaptability of banana at the fruit farm and in the laboratory of the Horticulture Research Centre, RARS, BARI, Jamalpur during the period from February 2014 to May 2015. There were significant variations among the lines/varieties in terms of all vegetative, fruit and yield characters. Plant height at shooting varied from 1.75 m to 3.21 m, where as ITC-570 got the shortest and Dud Sager the tallest plant. Dud Sager produced the height base girth (46.42 cm) as compared to the lowest base girth in ITC-570 (39.17 cm). Maximum number of leaves was obtained from Kari (8.17) whereas Dud Sagar produced minimum leaves (6.25). The highest number of hands per bunch was recorded in ITC-1320 (11.33) and the least in Kabri (5.75). ITC-1320 got the highest number of fingers per hand (16.51), whereas Kabri got the lowest fingers (11.08). ITC-1320 produced the highest fruit yield (35.65 t/ha) closely followed by ITC-570 (30.94 t/ha) whereas, Kabri produced the lowest yield (14.53 t/ha). ITC-1441 exhibited the highest shelf life (6.89 days) as compared to the lowest shelf in ITC-1320 (4.08 days). The germplasm- ITC-1320 and ITC-570 performed better in terms of yield and quality.

Regional yield trial of banana lines

Six germplasm of banana were evaluated to select the suitable lines as well as their regional adaptability of banana at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur during November 2013 to April 2015. Significantly wider variation was observed among the lines/varieties in respect of all vegetative, yield and yield contributing characters except finger diameter. BARI Kola 1 showed the shortest plant (166 cm) and Kabri produced the tallest plant (293 cm) followed by Dud Sagar (286 cm). ITC- 570 required shortest period (389 days) to harvest whereas Dud Sagar required the longest period (528 days) followed by Kabri (523days). The highest bunch weight was produced by ITC-1320 (25.97 kg) and the lowest by ITC-1441 (12.00 kg). The highest number of hands per bunch was recorded in ITC-1320 (12.47) and the lowest in BARI Kola 1 (8.20). The highest number of fingers per hand was also found in ITC-1320 (206), whereas it was noted the lowest in Kabri (95.67). The highest fruit yield was recorded in ITC-1320 (51.31 t/ha) and the lowest in ITC-1441 (23.61 t/ha). Maximum TSS was found in Dud Sagar (24.07 %) followed by ITC-570 (20.27 %) and Kabri (19.00 %) and minimum in ITC-1320 (15.07%).

Regional yield trial of banana lines

Four banana germplasm (ITC-570, ITC-1441, Dud Sagar and Kabri) were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar during 2013-2014. The highest plant height and base girth were observed in ITC-1441 (2.56 m and 55.33cm, respectively) and lowest plant height in ITC-570 (1.48 m) and the lowest base girth in BARI Kola 1(49.66cm). Number of hands per bunch was the highest in ITC-1441(7.33) and the lowest in Dud Sagar (6.0). Number of fingers/bunch and number of fingers/hand were highest in ITC-570 (i.e. 100.33and 13.00, respectively). Again, number of fingers per bunch was the lowest in Kabri (66.0) but in case of number of fingers/hands the lowest in ITC-1441 (11.67). Weight of individual fruit was the highest in BARI Kola 1 (138.33g) and the lowest in Dud Sagar (53.0g). Again, percentage of edible portion was the highest in BARI Kola 1 (64.63) and the lowest in ITC-570 (60.94). Yield per plant and yield per hectare were the highest in BARI Kola 1 (11.0kg and 27.67t/ha, respectively) and the lowest for Dud Sagar (6.0kg and 15.0 t/ha, respectively). Considering all the parameters none of the line performed better than the BARI Kola 1.

Regional yield trial of banana lines

The experiment was conducted at the Regional Agricultural Research Station, Jessore during 2014-15 to select the suitable variety and to know regional adaptability of banana. There were five lines in this experiment viz., ITC-570, ITC-1441, Dud Sager, Kabri and BARI Kola 1 as a check variety. The highest number of fingers per plant (109.67) was produced by the germplasm ITC-1441 and the lowest (53.00) was found in ITC-570. The germplasm Kabri produced the highest bunch weight (8.17 kg) followed by Dudh Sagar (7.13 kg). Number of hands per bunch (8.33) was obtained from the germplasm ITC-1441 followed by Dudh Sagar (6.13). The highest number of fingers per hand (13.07) produced by the germplasm ITC-1441 and the lowest in ITC-570 (8.87). The highest yield (7.38 kg/plant) was obtained from the genotype ITC-1441 whereas, the lowest yield (4.83 kg/plant) was found in the germplasm ITC-570. Considering yield and yield contributing characters the lines ITC-1441 and Kabri were found superior than others.

Compiled regional yield trial of banana lines at various locations

Six genotypes of banana were evaluated to select the suitable lines as well as their regional adaptability of banana at three locations viz. RARS, Jamalpur; BARI, Gazipur and RARS, Akbarpur during 2013-2015. In Gazipur, ITC- 570 noticed shortest period (389 days) to harvest whereas in Jamalpur, ITC-1320 required the shortest period (327 days) closely followed by BARI Kola 1 (330 days), ITC-570 (346 days). But in Akbarpur, the shortest period required to harvest in BARI Kola 1 and Kabri. The highest number of hands per bunch (12.47) and number of fingers per hand (206) at

Gazipur were recorded from ITC-1320. In Jamalpur, the highest number of hands per bunch and number of fingers per hand (16.51) also obtained from ITC-1320. The individual finger weight at Gazipur was observed in BARI Kola 1 (132 g) followed by ITC-1320 (129 g), but in Jamalpur, it was the highest in Dud Sagar (120 g) followed by BARI Kola 1 and in Akbarpur it was in BARI Kola 1. In Jamalpur and Gazipur, ITC-1320 produced the highest bunch weight (16.54 kg and 25.97 kg) whereas, in Akbarpur BARI Kola 1 produced the highest bunch weight. The highest fruit yield was recorded from ITC-1320 both in Jamalpur and Gazipur (35.65 t/ha and 51.31 t/ha, respectively which was closely followed by ITC-570 (30.94 t/ha and 29.20 t/ha in Jamalpur and Gazipur, respectively whereas, in Akbarpur BARI Kola 1 produced the highest yield.

Based on the results obtained from three locations, it may be concluded that the germplasm, ITC-1320, Dudh Sagar and ITC-570 performed better in terms of yield and quality.

Adaptive trial of BARI released banana varieties in Patuakhali region

Three BARI released banana varieties BARI Kola 1, BARI Kola 3, BARI Kola 4 and one local Sobri kola were evaluated at Regional Horticulture Research Station, Lebukhali, Patuakhali during 2014-15. Fruit yield was higher in BARI released varieties than local Sobri. Maximum 38.29 tha^{-1} was recorded in BARI Kola 04 and minimum 13.63 tha^{-1} in local Sobri.

Evaluation of plantain germplasam

Twenty two germplasm including BARI Kola 2 were evaluated at RARS, Burirhat, Rangpur during 2014-15. Maximum plant height at harvest (3.2 m) was recorded in MP Bur-019 while minimum in BARI Kola 2 (2.4 m). The germplasm MP Bur-008 required maximum days to shooting (303.6) while minimum days to shooting (251.6) was observed in MP Bur-004 and MP Bur-007. Maximum days to harvest (380) were required in MP Bur-020 whereas minimum in BARI Kola 2(341.6). The results revealed that the germplasm MP Bur-004 gave the highest yield (24.13 t/ha) followed by MP Bur-019 (23.03 t/ha) in terms of yield and quality. Considering the yield and quality, the germplasm MP Bur-004 was the best yielder (24.13 t/ha) followed by MP Bur-019 (23.03 t/ha).

Regional yield trial of plantain lines

Six local and exotic genotypes of plantain were evaluated at RARS, BARI, Jamalpur during the period from February 2014 to May 2015. The germplasm MP-24 produced the tallest plant (3.57 m) and BARI Kola 2 (1.93 m) had the shortest plant. MP-15 exhibited the highest base girth (61.25 cm) as against the lowest base girth in BARI Kola 2 (46.08 cm). The germplasm MP-18 demonstrated the maximum number of leaves (8.30) as compared to the minimum number of leaves in MP-15 (6.05). MP-15 produced the heaviest bunch (13.95 kg) as compared to the lowest bunch weight in BARI Kola 2 (9.04 kg). MP-15 produced the widest bunch (38.94 cm) while MP-ISD-02 produced the narrowest (33.86 cm) bunch. Peduncle weight was maximum in MP-15 (1.21 kg) and minimum (0.83 kg) in MP-18. The highest (34.86 t/ha) fruit yield was noted from MP-15 and the lowest from BARI Kola 2 (22.59 t/ha). Considering yield and yield contributing characters the line MP-15 was found promising.

Regional yield trial of plantain germplasm (set-1)

A study was carried out to observe the performance of five plantain genotypes at the Fruit Research Farm of HRC, BARI, Gazipur during November 2013 to April 2015. There was significant variation among the lines in respect of plant height, base girth, bunch weight, number of finger per bunch, individual finger weight as well as yield. The genotype MP- 010 produced the highest bunch weight (14.70 kg) as well as yield (29.05 t/ha) followed by MP-007 (14.37 kg and 28.39 t/ha). The genotype MP-010 produced the highest (185 g) individual finger weigh followed by BARI Kola 2 (170 g). All the genotypes performed better cooking quality. Considering bunch weight, number of fingers per bunch, individual finger weight and yield (t/ha) the genotypes MP-010 and MP-007 performed very well.

Regional yield trial of plantain lines (set-2)

Performance of six plantain genotypes was studied at Fruit Research Farm of HRC, BARI, Gazipur during November 2013 to March 2015. There was wider variation among the lines in respect of plant height, sucker number, days to harvest, bunch weight, number of hand, number of finger per bunch, yield and fruit size. The genotypes widely varied in respect of yield components and yield. MP-015 produced the highest bunch weight (13.67 kg), number of hands (6.50) and fingers (72.17) which ultimately contributed to attained the highest yield (27.00 t/ha). But MP-015 matured late (413 days) while MP-ISD-02 matured the earliest. MP-ISD-02 had the highest individual finger weight (181 g) and the lowest (150 g) by the MP-024. All the germplasm performed very well in respect of cooking quality.

Regional yield trial of plantain lines

The experiment was conducted during *rabi* 2013-14 with five advanced plantain lines against BARI Kola 2 at RARS, Rahmatpur, Barisal to select the suitable lines. The tallest plant (2.48m) was observed in MP-ISD-02 and the shortest plant (2.20m) was observed in MP-01. Maximum weight of bunch (7.74 kg) was found in MP-ISD-02 while the minimum was found in MP-24 (5.61 kg). The highest yield was produced by MP-ISD-02 (19.35 t/h) followed by MP-18 (18.29 t/h) and the lowest yield was produced by MP-24 (14.04 t/h). Considering fruit yield, single fruit weight and other characteristics MP-ISD-02 was found promising.

Regional yield trial of plantain lines

Five plantain germplasm (MP-1, MP-15, MP-24, MP-ISD-02) were included in this study and BARI Kola 2 was used as check. The highest plant height and base girth were observed in MP-24 (3.04 m) and in MP-15 (62.66 cm) and the lowest plant height in MP-18 (2.08 m) and base girth in BARI Kola 2(53.33 cm). Number of hands bunch, number of fingers/bunch and number of fingers/hands were highest in MP-1(i.e. 6.33, 73.67 and 15.33, respectively). Again, number of hands per bunch and number of fingers/bunch were lowest in MP-ISD-02 (4.33 and 44.67, respectively) but in case of number of fingers/hands the lowest in MP-18(9.50). Weight of individual fruit was the highest in MP-24 (151.67 g) and the lowest in MP-15 (86.67g). Again, percentage of edible portion was the highest in MP-18(68.43) and the lowest in MP-15(54.20). Yield per plant and yield per hectare were the highest in MP-1(8.36 kg and 20.91 t/ha, respectively) and then for MP-24(7.76 kg and 19.40 t/ha, respectively). Considering all the traits MP-1 and MP-24 performed better and these two lines are promising.

Regional yield trial of plantain lines

Performance of five plantain lines with BARI Kola 2 as check were studied at Regional Agricultural Research Station, Ishwardi, Pabna during 2014-15. The highest plant height (2.89 m) was recorded from MP-24 and the lowest (2.45 m) in BARI Kola 2. Early flowering (273 days) and harvesting (337 days) was done in MP-02 and later in BARI Kola 2 (315 days and 385 days, respectively). The number of fingers per bunch was maximum (72) in BARI Kola 2 and minimum (40) in MP-02. The highest bunch weight (10.07 kg) as well as yield (25.19 t/ha) was recorded from 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 line of MP-24 and MP-01 were found as superior. This is the first year trial. The trial will be continued.

Regional yield trial of plantain lines

Performance of six plantain genotypes were studied at the Regional Agricultural Research Station, Jessore during 2014-15 to find out suitable plantain germplasm for cultivation. The genotypes varied widely in respect of yield components and yield. The genotypes MP-15 produced the highest bunch weight (11.10 kg), number of hands (5.50) per bunch and number of fingers per hand (10.53) as well as yield (11.10 kg/plant). On the other hand, MP-ISD-02 produced the lowest bunch weight (9.80 kg) and number of hands (4.17) per bunch. The genotype MP-18 produced the lowest number of fingers per hand (9.80) and the lowest yield (6.63 kg/plant) was obtained from the line MP-01. Considering yield and yield contributing characters the lines MP-15 and MP-18 were found superior.

Compiled regional yield trial of plantain lines (set-1) at various locations

A study was carried out to observe the performance of five plantain genotypes at the Fruit Research Farm of HRC, BARI, Gazipur to find out their regional adaptability during 2011-12, 2012-13 and 2013-15. In 2013-15 there was significant variation among the lines in respect of plant height, base girth, bunch weight, number of finger per bunch, individual finger weight as well as yield. The genotype M- 010 produced the highest bunch weight (14.70 kg) as well as yield (29.05 t/ha) followed by MP-007 (14.37 kg and 28.39 t/ha). In respect of individual finger weight, the genotype MP-010 produced the highest (185 g) followed by BARI Kola 2 (170 g). All the genotypes performed better cooking quality. Average yield of three years was recorded higher (27.83 t/ha) from MP-010 closely followed by MP-007 (25.56 t/ha) and the lowest yield was obtained from MP-024 (24.06 t/ha).Considering bunch weight, number of fingers per bunch, individual finger weight and yield (t/ha) the genotypes MP-010 and MP-007 performed very well. Considering three years result, MP-007 and MP-010 genotypes performed very well in respect of earliness, yield and fruit size. MP-007 and MP-010 can be released as plantain varieties.

Compiled regional yield trial of plantain lines (set-2) at various locations

Performance of six plantain genotypes was studied at BARI, Gazipur; RARS, Akbarpur; RARS, Jessore; RARS, Jamalpur; RARS, Rahmatpur and RARS, Ishurdi during November 2013 to March 2015. In Gazipur, there was wider variation among the lines in respect of plant height, sucker number, days to harvest, bunch weight, number of hand, number of finger per bunch, yield and fruit size. The genotypes widely varied in respect of yield components and yield. MP-015 produced the highest bunch weight (13.67 kg), number of hands (6.50) and fingers (72.17) which ultimately contributed to attained the highest yield (27.00 t/ha). But MP-015 matured late (413 days) while MP-ISD-02 matured the earliest. MP-ISD-02 had the highest individual finger weight (181 g) and the lowest (150 g) by the MP-024. The highest yield was obtained from MP-015 in Jamalpur (34.86 t/ha) and Gazipur (27.00 t/ha). In Rahmatpur, 19.35 t/ha from MP-ISD-02 followed by MP-015 (18.29 t/ha), in Jessore 21.93 t/ha and 17.33 t/ha from MP-015 and MP-018 respectively. In Akbarpur, yield per hectare was highest in MP-001 (20.91 t/ha) followed by MP-024 (19.40 t/ha) and in Ishurdi, the highest yield (25.19 t/ha) was recorded from MP-024. Cooking quality of all plantain genotypes was observed good. Considering all the location the line MP-015 and MP-ISD-02 were found promising.

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 during February 2014 to May 2015. Six local and exotic banana genotypes were included in the study. Significant differences were observed among all the local and exotic lines in respect of all vegetative, finger and yield characters. The line SB-3 produced the tallest plant (5.65 m) and SB-6 the shortest plant (4.27 m). Base girth and number of leaves were found maximum in SB-10 (61.11 cm) and SB-3 (9.33), respectively. The line SB-3 exhibited the highest bunch weight (23.08 kg) & number of hands per bunch (14.50.) The highest average weight of individual hand (2.06 kg) was found in SB-10. The length and breadth of bunch were noted maximum in the line SB-3 (60.83 cm and 44.00 cm), respectively. Number of fingers per hand was noted highest in SB-9 (15.16). SB-10 exhibited the biggest finger (215.53 g) as against the smallest finger in SB-ISD-01 (101.67 g). The line SB-3 gave maximum yield (54.18 t/ha), while SB-4 exhibited minimum yield (33.53 t/ha). Considering yield and yield contributing characters, the lines; SB-3, SB-6 and SB-10 were found promising under Jamalpur condition.

Development of population for gynodioecious papaya variety

The study was carried out at the Fruit Research Farm of Pomology Division, HRC, BARI, Gazipur during the period from December 2013 to November 2014 to develop gynodioecious population for developing papaya variety containing 100% productive plant and to increase farm income through papaya cultivation. Seedlings of S_1 and F_1 progeny were planted in the main field on 07 March 2014. Total 438 seedlings of S_1 progeny were planted and it was observed that 275 andromonoecious plants and 163 female plants but no male plant was noticed in the population. On the other hand, in 51 plants of F_1 (Shahi X CP Joy-005) population, it was found 31 andromonoecious and 20 female plants without any male plants. Number of fruits per plant was found 20 and 18 in S_1 and F_1 progeny, respectively. The flesh colour of S_1 fruits was noticed bright yellow but it was found very light pink colour in F_1 fruits. The shape of S_1 and F_1 progeny was found elongated and oval, respectively. The TSS (%) of the fruits was found 10.50 in S_1 progeny and 9.30 in F_1 progeny. Seeds of S_2 and BC_1 progeny have been sown in the seed bed on December 2014. Evaluation of S_2 and BC_1 progeny along with new germplasm will be continued.

Purification of Shahi pepe

An experiment was carried out at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to purify the Shahi pepe variety during 2014-15. Selfed seeds of purified Shahi pepe were collected from identified deep red fruits which were Shahi shaped. Seedlings of purified selfed seeds were transplanted in the main field on February 2015 and five flowers in each plant were selfed (Sib mating) from May to July 2015. Female and male plants were maintained at 10:1 ratio, after flowering only one plant per pit was maintained and others were eradicated. A total of 500 flowers were selfed, among those 490 numbers of fruits were set. Among the different characters of Shahi pepe, two important characters like pulp color and TSS were restored successfully and others were very close to its original characters.

Hybridization in guava

A study was initiated at HRC, BARI, Gazipur during 2010-2011 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. 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 and yield.

Hybridization in litchi

Hybridization in litchi was carried out at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur during the flowering season of 2015 to incorporate some important characters like earliness, lateness, colour, regular heavy bearing in the desired variety or cultivar. Cross combination for hybridization were: BARI Lichu 3 x BARI Lichu 4, BARI Lichu 2 x BARI Lichu 4, BARI Lichu 3 x BARI Lichu 1, Kathali x BARI Lichu 4, and Early Bedana x BARI Lichu 1. The successful crosses with BARI Lichu 2 x BARI Lichu 1 produced 2 fruits, Kathali x BARI Lichu 4 produced 3 fruits and Early Bedana x BARI Lichu 1 produced 4 fruits. Seedlings have been raised and hybrid characters will be evaluated for selection.

Collection and evaluation of litchi germplasm

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet with 9 litchi germplasm. A wide variation was observed in case of growth characteristics, viz. plant height, base girth, canopy spreading and growth condition. LC Jai-051 and LC Jai-052 were found best among the germplasm tested. BARI Lichu 3 was found in excellent growth condition whereas BARI Lichu 2 showed poor growth condition.

Evaluation of existing coconut germplasm

The present study was conducted at CRS, Jaintiapur, Sylhet to evaluate the existing germplasm. Twenty two germplasm was initially included in the study. There were differences among the germplasm studied regarding plant height, base girth, and growth condition. 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 nuts were 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 found from CN Jai-001 (TSS 10%). In case of mature fruit the maximum fruit weight was found from CN Jai-016 (1900 g), but fruit size was highest in CN Jai-017 (28.0×16.0 cm) with the highest weight of fruit nut (1410 g) and maximum pulp weight (660 g). But the highest percent TSS (13%) of pulp was recorded from CN Jai-016. Considering all the parameters CN Jai-001, CN Jai-016, CN Jai-017 are much superior to other germplasm studied.

Collection and evaluation of existing ber germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapai Nawabganj during the period of August 2014 to May 2015 to find out the superior cultivars of ber for cultivation in that region as well as to find out late variety. In this experiment 10 ber germplasm namely Apel kul, BARI Kul-1, BARI Kul-2, BAU Kul-1, Comilla Kul, Sabji Kul and Chapai Kul and Thai kul were used. 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 was recorded in BARI Kul 1(21%) and the lowest in Sabji kul (16%). The highest (98%) and lowest (94%) edible portion was recorded in Thai kul and Chapai kul, respectively. The highest yield was obtained from Thai Kul (50.04 t/ha) and the lowest (27.80 t/ha) from BARI Kul 1. Chapai Kul harvested on 16th April considered as too late among the studied germplasm.

Collection and evaluation of ber germplasm

An experiment was conducted at HRC Fruit Orchard, RARS, Jamalpur during the fruiting season of 2014-2015 to identify suitable ber germplasm. Thirty two accessions were included in the study. Wide range of variation was noted regarding quantitative and qualitative fruit characters. Plant spread (N-S & E-W) ranged from 3.50 to 6.60 m and 3.50 to 6.40 m, respectively. Plant height ranged from 2.10 to 5.50 m. Base girth ranged from 25.00 to 64.00 cm. Flowering time of all ber germplasm was on August to September, 2014. Among 32 ber germplasm, harvesting time of 22 germplasm was on February, 2015 and 10 germplasm on February to March, 2015. Individual fruit weight ranged from 3.67 to 25.84 g, where ZM Jam-052 had the maximum, ZM Jam-103 had the 2nd highest and ZM Jam-204 got the minimum fruit weight. Fruit length and fruit breadth varied from 1.75 to 4.41 cm and 1.80 to 3.50 cm, respectively. Stone weight ranged from 0.47-1.80 g. Stone length and breadth varied from 0.88 to 2.68 cm and 0.58 to 1.18 cm, respectively. Number of fruits per plant varied from 525.16 to 3605.77. Yield per plant varied from 5.00 to 35.00 kg, where ZM Jam-235 got the minimum and ZM Jam-009 had the maximum and ZM Jam-008 had the 2nd highest yield per plant. TSS (%) varied from 9.00 to 20.00, where ZM Jam-150, ZM Jam-229 & ZM Jam-235 got maximum and ZM Jam-009, ZM Jam-145 & ZM Jam-283 exhibited minimum TSS. Edible portion varied from 83.24 to 94.86%, where the line ZM Jam-235 had the least and ZM Jam-010 got the highest value. Oval, oblong and round shaped fruits were observed among the germplasm. Fruit skin color ranged from yellow, light yellow, yellowish, yellowish green, yellowish with reddish shade, greenish yellow, green and reddish in color. Flesh color varied from white, creamy white, off-white, cream and light yellow in color. Regarding crispiness a wide range of variations was noted among the ber lines which were crispy and medium crispy. 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. All the lines exhibited smooth skin surface.

Evaluation of indigenous ber genotype

The experiment was conducted at Agricultural Research Station, Pahartali, Chittagong during 2014-2015. The genotypes produced flower in August-September and the fruits were harvested during February to March. Individual fruit weight was 16.11 g. The length and breadth of the fruit was 1.74 and 1.66 cm, respectively. The edible portion was recorded 93.59%. The number of fruits per plant was 2560. Yield was 43.10 kg. Total soluble solid was 13.50 %. Taste was very good.

Collection and evaluation of ber germplasm

The present study was conducted at 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 was observed in case of ZM Jai-003. Maximum number of fruits/plant (4515) and the highest yield (35.40 t/ha) was obtained from ZM Jai-003. There were variations among the quantitative fruit characters also. The largest fruit (4.25×3.6 cm) with maximum fruit weight (28.31 g) was obtained from ZM Jai-003. Maximum TSS% was found from ZM Jai-002 (11.8%) while maximum edible portion was found from ZM Jai-003 (92.42%).

Collection and evaluation of ber germplasm

A study was conducted at the Fruit Research Station, Binodpur, Rajshahi with 10 local and exotic ber germplasm during 2014-2015. Skin colour of most of the ber varieties varied from light greenish yellow to greenish yellow. The fruit surface of ber fruit of all varieties were more or less smooth except few exception in BARI Kul-1. Harvesting period varied from February to Mid April. Most of the genotypes produced fruit during mid season (February). ZM Bin-015 (China Kul) produced the maximum weight of the fruit (55.0 g) and it was minimum weight in ZM Bin-001 (Apple Kul) (15.0 g). The highest total soluble solids (18.0%) was recorded in ZM Bin-002 (BARI Kul 1) while the lowest in ZM Bin-005 (11.0%), ZM Bin-007, ZM Bin-015 (Dhaka-90 Kul, Khulna Kul & China Kul). The ZM Bin-014 (BARI Kul 3) gave the highest yield (25.61 t/ha) followed by ZM Bin-012 (Local Kul late) (14.21 t/ha) and it was the lowest in ZM Bin-016 (Umboly Kul) (10.25 t/ha). Local Kul (late) was found to be very promising for late season.

Collection and evaluation of local ber (sour) gerplasm

A study was conducted at the Bio diversity conservation area, Fruit Research Station, BARI, Binodpur, Rajshahi and Manda, Naogaon with 42 lines during October, 2014 to March, 2015 to select the superior sour ber germplasm for processing purpose for cultivation in Northern Region of Bangladesh. Twenty fruits of each tree were plucked randomly of which ten were used for studying their physical and qualitative characteristics. The germplasm ZM Bin-041 produced the largest fruit (17.00 g) and the line ZM Bin-011 produced the smallest fruit (6.5 g). The stone weight ranged from 0.6-1.2 g. Considering fruit characteristic and yield potentialities ZM Bin-003, ZM Bin-029, and ZM Bin-041, were found to be superior for cultivation in Northern Region of Bangladesh.

Evaluation of local pummelo lines

Evaluation of local pummelo lines was conducted at Citrus Research Station, Jaintapur, Sylhet to study their performance. 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 from CG Jai-008 (38.4 kg) with maximum fruit size (14.38×14.45 cm). The highest per cent edible portion was obtained from CG Jai-007 (60.59%) while the lowest from CG Jai-011 (48.04%) and maximum per cent TSS was recorded in CG Jai 008 (10.23%) followed by CG Jai 009 (9.40%) and CG Jai-007 (9.25%) respectively. CG Jai-001, CG Jai-006, CG Jai-007 and CG Jai-008 was found promising in respect of yield, per cent edible portion and per cent TSS among the lines evaluated.

Collection and evaluation of local pummelo germplasm

The study was carried out at RARS, Burirhat, Rangpur during 2014-15. Twenty two germplasm including BARI Batabilebu 2 were evaluated. Maximum fruit weight (2960 g) was obtained from CG Bur-014 and minimum from CG Bur-015(798 g). Fruit length and circumference were also found maximum (20.0 cm and 70.0 cm) in the same germplasm CG Bur-014 and minimum fruit length and circumference (10.5 cm and 40.0 cm) were also found in the same germplasm CG Bur-015. The highest number of segments per fruit (18.0) was observed in CG Bur-005 and CG Bur-014 while the lowest number of segments per fruit (10.0) was observed in CG Bur-021. Skin thickness was recorded maximum in CG Bur-014(25 mm) and minimum in CG Bur-017 (9.0 mm). The germplasm CG Bur-002, CG Bur-004, CG Bur-005, CG Bur-006, CG Bur-008, CG Bur-009, CG Bur-011, CG Bur-012, CG Bur-013, CG Bur-014, CG Bur-017, CG Bur-018, CG Bur-019 and CG Bur-021were better in respect of fruit quality.

In-situ evaluation of year round pummelo germplasm

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2014-15. An off-season pummelo germplasm (CG Kha-001) was selected for evaluation to compare with a normal season pummelo germplasm. Mainly 2 seasons bearing occurred in the germplasm. Five fruits from each fruiting season were randomly selected for evaluation. Fruit weight ranged from 1.57 kg to 1.18 kg. The edible portion (48.02%) was obtained from the control germplasm and 39.14% from the off-season germplasm. The TSS (10.0 %) was obtained from the control germplasm and 9.0 % from the off-season germplasm. The number of fruits per plant was observed to be 154 in CG Kha-Off-001 and 48 in CG Kha-Off-002. The germplasm CG Kha-Off-001 was found promising for year round cultivation of pummelo at hilly region.

Evaluation of local pummelo germplasm

Five germplasm of pummelo viz. CG Hat-001, CG Hat-002, CG Hat-003, CG Hat-004 and CG Hat-005 were evaluated at the Regional Agricultural Research Station Hathazari, Chittagong during 2014-2015. Fruit weight of the germplasm ranged from 705g (CG Hat-004) to 825g (CG Hat-001). The highest edible portion was obtained (68.51%) in CG Hat-003. TSS varied from 10-12%. The highest number of segment was found in CG Hat-004 (16) and CG Hat- 003(16). Fruits were either pyriform or oblate in shape. Fruits of CG Hat-002 and CG Hat-003 were very sweet and tastes. Considering fruit size, bearing and quality of fruits the lines CG Hat-002 and CG Hat-003 were found promising.

Evaluation of mandarin germplasm

The experiment was conducted to study the performance of thirteen mandarin orange germplasm collected from different locations of the country and planted at Citrus Research Station, Jaintapur, Sylhet along with BARI Kamala 1 as a cheek. All the germplasm were found satisfactory considering growth parameters like plant height, base girth, spreading and number of branches per plant. However, CR Jai-104, CR Jai-105, CR Jai-106 and CR Jai-109 performed the best among the germplasm studied. Plant height ranged from 87.33 cm to 207.7 cm in different germplasm with the tallest in CR

Jai-106 (207.7 cm) and the shortest in CR Jai-110 (87.33 cm). CR Jai-104 performed the best regarding the highest base girth (7.8 cm) and the highest canopy size (101.0×86.33 cm). All the plants are in good growth condition. Among the germplasm, CR Jai-104, CR Jai-105, CR Jai-106 and CR Jai-109 were found superior regarding growth characteristics studied.

Evaluation of exotic mandarin lines

Four germplasm of exotic mandarin orange were collected and planted at the Citrus Research Station, Jaintiapur, Sylhet in July 2008 to study their performance under the agro-ecological condition of Sylhet. CR Jai-007 was found superior with plant height, base girth, canopy, spreading and the highest number of fruit (17). CR Jai-053 was superior with excellent growth condition but it dodn't bear fruit this year. Fruit quality of CR Jai-007 was good and will be further investigated.

Evaluation of grafted mandarin (C*itrus reticulata*) in hilly area

An experiment was conducted at six years old grafted mandarin orchards consisting of ten genotypes in Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2014-15. The grafted saplings of ten mandarin genotypes *viz.*, CSRai-022, CS Rai-023, CS Rai-024, CS Rai-025, CS Rai-026, CS Rai-027, CS Rai-028, CS Rai-029, CS Rai-030 and CS Rai-031 were planted in August 2009. The maximum number of fruits per plant was observed in CR Rai-031 (543) followed by CR Rai-022 (499) and CR Rai-023 (363), whereas there were no fruits in CR Ra-i029. The time to first flowering was March in all the genotypes except CR Rai-025 where the first flowering took place in February. The mandarin genotype CR Rai-031, CR Rai-022 and CR Rai-023 were supposed to be superior for number of fruit set. This experiment will be continued for confirmation of the result.

Evaluation of superior lines of sweet orange (C*itrus sinensis*)

The study was conducted at Citrus research Station (CRS), Jaintapur, Sylhet. Seven superior lines of sweet orange were tested with BARI Malta 1 as check. Significant differences were observed among the germplasm in terms of growth, yield, yield contributing and fruit characters. The highest number of fruit was found from BARI Malta 1 (242), its fruit yield was lower (38.72 kg/tree and 24.20 t/ha with 4×4 m spacing) but maximum yield/tree (67.58 kg) was obtained from CS Jai-001 with 42.23 t/ha of yield. Minimum yield was from CS Jai-007 (6.92 t/ha). Fruit size attained maximum from CS Jai-001 (10.20×11.53 cm) followed by CS Jai-002 (7.40×8.88 cm). BARI Malta 1 was found with the smallest fruit size (6.0×5.80 cm). Pulp and rind weight showed the similar pattern with maximum from CS Jai-001 (565.0 g and 180.0 g, respectively) and the lowest from BARI Malta 1 (92.50 g and 57.68 g, respectively). Maximum percent TSS was found from CS Jai-007 (9.7 %) while the lowest was from CS Jai-002 (7.6%). Medium juice content was found from CS Jai-003, CS Jaio-004 along with BARI Malta 1 whereas the other were found to have high level of juice in pulp. The highest TSS (%) 10.1 was found in CS Jai-003 followed by CS Jai-001. The highest fruit weight (205g) was obtained from CS Jai-002 while the lowest (120g) was obtained from BARI Malta 1. Among the germplasm, CS Jai-003 can be released as a new sweet orange (Malta) variety. However, CS Jai-002 and CS Jai-001 were also promising.

Evaluation of exotic lemon germplasm

One lemon germplasm was collected from Greece and planted in 2008 at private nursery, Fatepur, Charghat, Rajshahi. In 2012, the germplasm was collected from that nursery and planted at Fruit Research Station, Binodpur, Rajshahi. The germplasm was studied during January to July 2015. The plants were 4 years old and still in vegetative stage. The plant height, base girth, number of primary branches were 3 m, 30 cm and 3, respectively. The plant produced 45 fruits this year. Growth condition of the germplasm was good.

In- situ evaluation of lemon germplasm in char land

Two lines of lemon such as Jam Cl-001 and Jam Cl-002 were evaluated at the farmer's field in char land of Sherpur and Jamalpur during the year 2014-15. Maximum number of fruit/year (1350) was obtained from Jam Cl-001. Higher single fruit weight (92 g) was obtained from Jam Cl-002. The line Jam Cl-001 was year round and seed less. On an average 54 of seed were found from the line Jam Cl-002 and it was scented. Considering fruit size, yield and quality of fruits the line Jam Cl-001 was found promising.

Collection and evaluation of jara lebu germplasm

Six lines of jara lebu namely CM Akbr-001, CM Akbr-002, CM Akbr-003, CM Akbr-004, CM Akbr-005 and CM Akbr-006 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar during the year 2014-15. Maximum single fruit weight (855.0 g) was obtained from CM Akbr-001 followed by CM Akbr-003 (840.0 g) and CM Akbr-002 (467.0 g). Fruit length ranged from 7.45 cm (CM Akbr-006) to 17.0 cm (CM Akbr-001) and fruit breadth was 4.82 cm (CM Akbr-006) to 12.50 cm (CM Akbr-001). The highest rind thickness was also obtained from CM Akbr-001 (2.35 cm) and the lowest rind thickness was 0.55 cm in CM Akbr-006. Number of seed was the lowest in CM Akbr-001(34.66) and the highest in CM-003(95.5). Pulp diameter was the highest in CM-004(5.89 cm) and the lowest in CM-006 (3.66 cm). Number of fruits per plant was the highest in CM-006 (43.0) and the lowest in CM-004 (8.0). Considering fruit size, rind thickness and quality of fruits the line CM-001 was found promising.

Evaluation of jara lemon germplasm

The experiment was conducted at CRS, Jaintiapur, Sylhet, during 2014 - 2015. The plants were planted in July 2012. A wide variation was observed in case of different growth characteristics of the Jara lemon germplasm tested. CM Jai-059 was superior with the highest plant height 197.0 cm, base girth (20.0 cm) and large canopy size (99.67×124.0 cm) and good growth condition. CM Jai-059 fruited for the first time with 480 g individual fruit weight yielded 5.75 kg/plant of fruits that predicted to yield 6.4 t/ha. The size of the fruit was (16.6×7.4 cm). Thickness of the rind (main edible portion) was also higher (18 mm) with TSS of 2.0% and 71% of the total edible portion (rind).

Morphological characterization of jara lemon

An effort has been made for in situ characterization of Jara lemon. Three distinct type of Jara lemon accessions viz. Pani jara, Gul jara and Guti jara have been included in this programme and were characterized. A wide variability was observed in different characters among the different germplasm studied. Among the varieties/lines Jara lemon produced flower year round although little or no fruit set in winter.

Evaluation of burmese grape germplasm

The experiment was conducted at CRS, Jaintiapur, Sylhet with five Burmese grape germplasm. A wide variation was observed in case of growth, yield contributing characters, yield and fruit quality of the germplasm. The highest plant height, base girth, canopy spreading was found from BS Jai-005. Leaf size was also maximum in this line. Maximum number of fruits/plant, yield/plant and yield/ha were obtained from BS Jai-001. BS Jai-001 was also free from disease where as the others suffer from powdery mildew and sooty mould. Chaper beetle was common in case of all the germplasm and only BS Jai-001 was free from fruit borer. Fruit size was maximum in BS Jai-003 (3.4×3.4 cm) followed by BS Jai-001 (3.35×3.14 cm). Flesh color and texture for all germplasm was off white and juicy. Maximum edible portion (47.5%) and per cent TSS (13.6%) was found from BS Jai-001.

Evaluation of lukluki germplasm

Ten lines of Lukluki such as Lu Akb-004, Lu Akb-006, Lu Akb-007, Lu Akb-008, Lu Akb-011, Lu Akb-012, Lu Akb-016, Lu Akb-017, Lu Akb-020 and Lu Akb-021 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar during the year 2014-15. Maximum single fruit weight (9.60 g) was obtained from Lu Akb-007 followed by Lu Akb-004 (8.18 g) and minimum was in Lu Akb-012 (4.88 g). The highest pulp weight was found from the line Lu Akb-007 (6.35 g) and minimum was in Lu Akb -016 (2.47 g). The number of seeds (11.67) and weight of seeds/fruit was also moderate in the line Lu Akb-007(1.28g). The highest TSS was obtained from Lu Akb-007 (20.15%) and the line was very good in taste. The line Lu Akb-007 was found better among the germplasm.

Collection and evaluation of existing bel germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapainawabganj during 2014-15 to find out a good genotype of bel for commercial cultivation. Twenty two germplasm were included in this experiment which were collected from different places of Chapainawabganj and Rajshahi district. A wide variation was observed among the germplasm regarding growth and tree characteristics. Among the fruit characteristics, fruit weight varied from 650-1900 g, fruit length 6.8-19.7 cm, fruit breadth 10.6-50.0 cm, pulp weight 414-1412 g, fibre weight 33-80 g, seed weight 16-45 g and TSS 28-36 %. Fruit yield per hectare was recorded the highest in AM Cha-0 06 12.2 ton and the lowest in AM Cha-019 (260 kg). Among the germplasm, only one germplasm produced early fruits, 7 produced medium fruits and 3 produced late harvested on end of April. Considering overall assessment 6 germplasm have been found superior and among these genotypes AM Cha-05 could be selected for releasing as bel variety as BARI Bel 1in this year. Among the germplasm only 11 germplasm produced flowers and fruits in this year. Among the germplasm AM Cha-009 germplasm was considered as early germplasm and fruits were harvested on 15 March. In consideration of fruit characteristics and edible portion, flavour, AM Cha-002, AM Cha-005, AM Cha-006, AM Cha-09 and AM Cha-013 were found promising. The available variability for various traits in bel germplasm can be utilized for improvement of this under utilized fruit. Germplasm having less seeds and mucilage content, less fibre content and better aroma can be used for improvement of this native fruit. Superior germplasm can be released as a variety for commercial cultivation. AM Cha-005 has been evaluated in the year 2014 and proposed as BARI Bel-1.

Evaluation of bel germplasm

The experiment was conducted at CRS, Jaintiapur, Sylhet, during July 2014 to May 2015. Five germplasm of bel was included in the study. A wide variation was observed in case of different growth characters of the germplasm tested. The highest plant height was recorded in case of AM Jai-004 but base girth was the highest from AM Jai-005 (132 m). AM Jai-001 was superior with bigger canopy size (8.7×7.6 m). The highest number of fruits (132) was found from AM Jai-003 with maximum yield (31.85 kg and 8.82 t/ha, respectively). There were variations among the quantitative fruit characters also. Maximum fruit weight was obtained from AM Jai-004 (550 g) with large sized fruit (11.2×10.4 cm). But AM Jai-001was superior with maximum TSS (40%), edible portion (63.76%).

Collection and evaluation of wood apple germplasm

The growth parameters of seven wood apple germplasm were evaluated in the Fruit Research Farm of HRC, BARI, Gazipur during 2014, which were planted in June 2009. No variation was observed in plant height, base girth, and canopy spread in E-W and N-S direction. Maximum plant height (3.27m) and base girth (37.67 cm) were observed in FL Joy-006 and FL Joy-007, respectively. Most of the fruit characters did not show any significant variation except fruit weight and fruit length 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-002 exhibited the maximum fruit length (7.67cm) where as FL Joy-007 exhibited the lowest fruit length (5.40 cm). TSS varied from 13.33 % (FL-Joy 003 and FL Joy-007) to 10.00% (FL Joy-004 and FL Joy-005). Fruit colour of most of the genotypes was grayish white and fruit shape of all the germplasm was round. 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 2014. No. of fruits per plant varied from 9 fruits /plant (FL Joy-001) to 25 fruits /plant (FL Joy-003and FL Joy-004). The study revealed that the germplasm FL Joy-002 and FL-Joy 03 were found superior with respect to quantitative and qualitative characteristics and yield of fruits.

Collection and evaluation of some pomegranate germplasm

Twelve germplasm of pomegranate were evaluated for their performance at RHRS, Chapai Nawabganj in the year of 2014-15. A wide variation was observed among germplasm. The highest number of fruits per plant was produced in PG Cha-002 (28) followed by PG Cha-011 (26). The heaviest fruit (208 g) was obtained in PG Cha-004 whereas the lightest fruit (168 g) was found in PG Cha-010. Percent edible portion was maximum (67.4%) in PG Cha-011 whereas the minimum edible portion (52%) was found in PG Cha-008. Total soluble solid content was the highest in PG Cha-012 (14.9%) while PG Cha-002 had the lowest (12.6%). PG Cha-010, PG Cha-011 and PG Cha-012 produced soft seeded arils. PG Cha-004 was the best yielder (5.07 kg/plant) with sour taste followed by PG Cha-012 with sweet taste. Considering the important parameters the genotypes PG Cha-012, PG Cha-010 and PG Cha-004 were found superior.

Evaluation of pomegranate germplasm

An experiment was carried out at the Fruit Research Farm, HRC, BARI, Gazipur during 2013-2014 to evaluate thirty nine pomegranate germplasm. Wide range of variation was observed with respect to plant height, base girth, canopy spread in respect of E-W and N-S orientation and number of fruit. Plant height was maximum (280 m) in PG Joy-002 and minimum (1.15 m) in PG Joy-030 and the base girth was recorded maximum (25 cm) in PG Joy-007, whereas it was noticed minimum (6 cm) in PG Joy-02. Individual fruit weight was recorded maximum (180 g) in PG Joy-039. The germplasm PG Joy-001 contained maximum total soluble solids (14.6 %). Fruit colour of most of the germplasm was observed orange red, while aril color was noticed white to medium red. The fruits of all the germplasm were harvested between July and September 2014.

Evaluation of custard apple germplasm

Some custard apple germplasm were studied in the Fruit Research Farm of HRC, BARI, Gazipur during the fruiting year of 2014. Wide range of variation was observed in plant height, base girth, canopy spread in E-W an N-S orientation and number of fruit. Maximum plant height was observed in AS Joy-001-2 (5.30 m) and minimum in AS Joy-014-2 (2.00 m). Maximum base girth was found to be 39.0 cm in AS Joy-010-1 and minimum in AS Joy-003-2(27.0 cm). Plant spread in the N-S orientation was observed maximum in AS Joy 004-1 (3.90 m) and minimum in AS Joy-003-2 (0.70 m). On the other hand, plant spread in the E-W orientation was found maximum in AS Joy -006-1 (3.60 m) and minimum in AS Joy-003-2 (1.0 m). Harvesting period of fruit lasted from August to October 2014. The number of fruits varied from 3 to 20. The weight of single fruit differed from 122 g to 176 g. Maximum and minimum edible portion were found 61.0 and 34.7 %, respectively. TSS ranged from 16.0 to 24.0% Brix. The custard apple germplasm AS Joy-015-2 was found superior with good quality pink coloured bigger fruit.

Evaluation of custard apple germplasm in hilly region

Ten custard apple germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The plants were planted at the Hill Tracts Agricultural Research

Station, Ramgarh during 2009 maintaining 4 m plant spacing in a single row. Five fruits from each plant were randomly selected for evaluation. Fully matured fruits were harvested for data collection. The line AS Ram-005 produced the maximum number of fruits (41/plant) with heavier fruit (219.2 g/fruit). The maximum fruit yield (8.97 kg/plant) was obtained from the line AS Ram-005 and the maximum TSS (19.41%) was recorded in AS Ram-003 closely followed by AS Ram-005 (18.67%). Based on yield and quality it might be concluded that the custard line AS Ram-005 was superior.

Collection and evaluation of custard apple germplasm

Thirteen custard apple germplasm were studied at Binodpur, Rajshahi during the fruiting season of2014. Wide range of diversity existed in fruit weight, pulp weight, TSS, pulp content, skin weight etc. The highest fruit weight (150 g) was observed in AS Bin-004 and the lowest in AS Bin-006 (68.40g). The highest skin weight was observed in AS Bin-004 (63.83 g) and the lowest in AS Bin-006 was (29.80 g). The highest TSS (25%) was recorded in AS Bin-002 and the lowest (18%) was found in AS Bin-008 and AS Bin-009. The germplasm AS Bin-004, AS Bin-011, AS Bin-012 and AS Bin-002 showed better performance on the basis of fruit weight and TSS value.

Collection and evaluation of some bullock's heart genotypes

A study was carried out at RHRS, Chapai Nawabganj during the period from March to May 2015 to find out superior genotypes of bullock˙s heart (*Annona reticulata* L). Fifteen genotypes were identified and fruits were collected from plants of different location of Chapai Nawabganj and Rajshahi districts. The heaviest fruit (394.9 g) was recorded in genotype AR Cha-013 whereas the lightest fruit (68.3 g) was found in AR Cha-001. The skin weight was the highest (83.3 g) in AR Cha-013 whereas the lowest skin weight (24.8 g) was found in AR Cha-001. The highest weight of seeds (25.4 g) was recorded in AR Cha-008 while the lowest seed weight (8.9 g) was found in AR Cha-005. The maximum pulp (337.3 g) was obtained from the fruits of genotype AR Cha-013. Whereas, the minimum weight of pulp (30.2 g) was got from AR Cha-001. The maximum edible portion (85.4%) was recorded in AR Cha-013 whereas the minimum in AR Cha-003. The genotypes AR Cha-004, AR Cha-011, AR Cha-014 and AR Cha-015 were found superior.

Evaluation of wax jambu germplasm

The experiment was conducted at the Regional Agricultural Research station, Akbarpur, Moulvibazar during 2014-15 with 5 Wax jambu lines. Maximum individual fruit weight (46.6 g) was obtained from SS Akb-001 and minimum was in SS Akb-005 (38.3 g). The maximum length of fruit was obtained from SS Akb-001 (6.8 cm) and the lowest from SS Akb-005 (4.9 cm). Maximum number of fruits/plant was observed in SS Akb-001 (2767) and minimum was in SS Akb-002 (12). Considering fruit size and quality of fruits the line SS Akb-001 was found promising.

Evaluation of indian olive germplasm

Three Indian olive germplasm were evaluated at CRS, Jaintiapur, Sylhet. The highest plant height was observed in EF Jai-013, base girth was maximum in EF Jai-002, EF Jai-007 and EF Jai-013 (90 cm). Line EF Jai-001 was superior with the biggest canopy size (6.5×6.0 m) while maximum individual fruit weight was obtained from EF Jai-007 (42.0 g) with larger size fruit (5.9×4.3 cm). The highest number of fruits/plant was obtained from EF Jai-009 (1880) but maximum yield was obtained from EF Jai-007 (59.39 kg/plant and 23.75 t/ha respectively). There were variations among the quantitative fruit characters also. The highest flesh thickness was found in EF Jai-002, EF Jai-003, EF Jai-007 and EF Jai-013 (1.5 cm) while edible portion was higher EF Jai-07 (90.52%). All the germplasm showed regular fruit bearing habit.

Evaluation of indian dillenia germplasm in hilly region

Five Indian dillenia germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The highest plant height (24.25 m) was recorded in DI Ram-005 but maximum base girth (205 cm) was found in DI Ram-003. The line DI Ram-003 had the highest canopy with E-W spread and N-S spread. The line DI Ram-003 produced the maximum number of fruits (599/plant) while heavier fruit (518.2 g/fruit) was produced by the line DI Ram-005. The maximum fruit yield (263.6 kg /plant) was obtained from the line DI Ram-005 and the lowest yield (52.248kg/plant) was recorded in DI Ram-004.

Evaluation of indian dillenia germplasm

Three local Indian dillenia germplasm were evaluated at CRS, Jaintiapur, Sylhet. The highest plant height, base girth and size of leaf were observed in case of DI Jai-003. DI Jai-001 was superior with bigger canopy size. The highest yield was obtained from DI Jai-001 (247.34 kg/plant and 37.10 t/ha). Large fruit was obtained from DI Jai-003 (870 g). The germplasm DI Jai-003 produced maximum TSS and edible portion which were 5.3 and 80.0%, respectively.

Evaluation of rose apple germplasm in hilly region

Five lines of rose apple namely SJ Ram-001, SJ Ram-002, SJ Ram-003, SJ Ram-004, SJ Ram-005 were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during the year 2015. The line SJ Ram-005 produced the maximum number of fruits (933/plant) while heavier fruits (15.8 g/fruit) produced by the line SJ Ram- 003. The maximum fruit yield (13.92 kg/plant) was obtained from the line SJ Ram-001 and it was the lowest from SJ Ram-003 (9.21 kg/plant). The maximum TSS (13.44%) was recorded in SJ Ram-001 having sweet taste and it was the lowest in SJ Ram-005 (10.23%).

Evaluation of exotic jamun germplasm

An experiment was carried out at the Horticulture Research Center, BARI, Gazipur during 2014-2015 to evaluate an exotic jamun germplasm (SC Ex-001). Plant height, base girth and number of primary branches were 5.1 m, 67.8 cm and 4.0, respectively. Flowering started from 1st week of February and continued up to 1st week of March and fruit setting took place during April. Fruit weight was 5.58 g having 2.80 cm length and 2.00 cm diameter. Seed weight was 1.05 g and edible portion was 81.18%. Ripe fruit was black in colour and TSS in fruit juice was 13.00%. The plant produced 5.50 kg fruit. Individual fruit weight was 5.58 g, edible portion was 81.18% having TSS 13.00%. The growth condition of the plant, fruit quality as well as yield were quite satisfactory.

Survey, collection and evaluation of jamun germplasm

A survey was conducted to collect information on jamun germplasm in the different areas of Rajshahi. Ten jamun germpalsm were studied during 2014-15. Wide variations in plant and fruit characteristics were observed among the germplasm. The highest fruit weight was obtained from SC Bin-012 (11 g) followed by SC Bin-005 (10 g). The maximum edible portion (85%) was obtained from SC Bin-005 followed by SC Bin-008 (84%) where as the minimum edible portion (70%) was found in SC Bin-004. The highest TSS (16%) was obtained from J-005. Maximum yield per plant was recorded form SC Bin-005 (50 kg) followed by SC Bin-001 (47 kg). Minimum yield per plant was recorded in SC Bin-012 (40 kg). Considering fruit quality, percent TSS, flesh type, edible portion and yield, SC Bin-005, SC Bin-008 and SC Bin-012 were superior to other germplasm.

Collection and evaluation of cowa germplasm

Growth characteristics of eleven cowa germplasm 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 during 2014-15. Wide range of variation was recorded among the germplasm. The highest plant height was recorded in GC Rah-07 (468 cm) and the lowest in GC Rah-10 (205 cm). The germplasm GC Rah-06 produced the highest number (707) of fruits and the germplasm GC Rah-03 the lowest (96). The highest individual fruit weight was found in GC Rah-

10 (45.6 g) and the lowest in GC Rah-02 and GC Rah-08 (32.0 g). The highest yield/plant was found in GC Rah-06 (28.0 kg) and the lowest in GC Rah-10 (4.38 kg).

Evaluation of cowa germplasm

Five cowa germplasm were evaluated at the Citrus Research Station (CRS), Jaintapur, Sylhet during 2014-15. A wide variation was observed in plant height, base girth, spreading, number of fruits/plant, fruit weight, edible portion and per cent TSS. The highest plant height, base girth, canopy size and number of fruits were observed in GC Jai-004. But maximum fruit yield/plant (144.0 kg) was obtained from GC Jai-018. Fruit weight was the highest in GC Jai-001 (24.16 g) but bigger fruit was obtained from GC Jai-018 (4.2×3.9 cm). Maximum per cent edible portion (43.5%) was obtained from GC Jai-004 but GC Jai-018 was superior in case of per cent TSS (14.3%). Considering all the parameters GC Jai-001, GC Jai-004 and GC Jai-018 were found superior.

Evaluation of avocado lines

A study was carried out at the Fruit Research Farm of Horticulture Research Center, BARI, Gazipur during 2014-15 to evaluate the avocado germplasm. Two germplasm were planted in 1996. The number of fruits of PA Joy-002 was 178 having average fruit weight 450 g. The TSS and edible portion were 7.5 and 80%, respectively. The germplasm PA-Joy 002 may be proposed as a variety for its good yield potentiality.

Evaluation of avocado lines

Six Avocado germplasm such as 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 during the year 2014-15. The observed plant height ranged from 620.0 cm in PA-Akb-005 to 810.0 cm in PA Akb-002. Base girth was maximum (118.0 cm) in AR Akb-002 and minimum (80.0 cm) in AR Akb-004. Bearing of fruits was the highest in PA Akb-003 (190) followed by PA Akb-005(155) and PA Akb-002(95). In case of fruit characteristics PA Akb-005 performed best for individual fruit weight (215.25 g), weight of seed (50 g), fruit and seed size respectively. The line PA Akb-005 performed better.

Evaluation of persimmon germplasm

A study was carried out at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur during 2014-15 to evaluate the growth, flowering and fruiting behavior of persimmon germplasm. The plant and fruit characteristics, time of flowering, fruit shape and colour, harvesting time and number of fruit per plants and seed characteristics of persimmon germplasm were studied. The plant height of DK Joy-002 was 5.20 m with number of branches (5.0) and the plant height of DK Joy-001 was 3.5 m with number of branches (3.0). The number of fruits per plant was obtained from DK-Joy 002 was 280. Individual fruit weight was 70 g in DK Joy-001 and 55 g in DK Joy-001. The TSS was recorded 15.0% in the germplasm DK Joy-001. Growth of both the germplasm was satisfactory and maximum yield was harvested from DK-Joy002.

Evaluation of exotic date palm (*Phoenix dactylifera* l.) in hilly areas

An experiment was conducted at the established five years old exotic date palm garden of Hill Agricultural Research Station of Raikhali in Rangamati Hill District during 2014-15 for the evaluation of 14 exotic date palm genotypes in hilly area. Higher number of fruits (816), fruit size (3.95 cm × 2.61 cm), individual fruit weight (12.36 g) and fruit yield per plant (10.06 kg) was observed in PD Rai-002 comparing to PD Rai-004.

Performance of grape germplasm

An experiment was conducted to evaluate 2 grape germplasm (VV Kha-001 and VV Kha-002) at the Hill Agricultural Research Station, Khagrachari during the period from February to July 2015. The full blooming period was February 15 and harvesting was done in July 15. The Maximum number of fruits per cluster (28) was recorded in VV Kha-001 while the maximum number of clusters per plant (13) was obtained from VV Kha-002. Individual fruit weight (3.60 g) was found maximum in VV Kha-002 with the highest number of seeds (2.4) per fruit. Total Soluble Solids (TSS) was noted the highest (18%) in VV Kha-001. The highest yield per plant was obtained from VV Kha-002 (1.17kg) and the lowest in VV Kha-001 (0.71 kg).

Performance comparison of BARI released strawberry varieties

BARI released three Strawberry varieties (BARI Strawberry 1, BARI Strawberry 2 and BARI Strawberry 3) were evaluated at the Fruit Research Farm, HRC, BARI, Gazipur during November 2014 to April 2015. First flowering of all the three varieties under study took place between end of December to mid January. First harvesting started between mid January to end of the month. Harvesting period varied from 78 to 102 days. The heaviest fruits were produced by BARI Strawberry 3 (34.3 g) followed by BARI Strawberry 2 (31.3 g) while the lightest fruit was found in BARI Strawberry 1 (21.5 g). Maximum number of fruits per plant (26) was obtained from BARI Strawberry 3 and the minimum (22) from BARI Strawberry 1. The highest fruit yield per plant (891.8 g) was recorded in BARI Strawberry 3 followed by BARI Strawberry 2 (719.9 g) and the lowest in BARI Strawberry 1 (473.0 g). TSS was the highest (10.9%) in BARI Strawberry 1 followed by BARI Strawberry 3 (8.4) while it was the lowest (8.3%) in BARI Strawberry 2. Fruit damage due to disease infestation was found higher in BARI Strawberry 1 in comparison to the other two varieties. Considering marketable yield and quality of fruit, BARI Strawberry 2 and BARI Strawberry 3 were found much better than BARI Strawberry 1 except sweetness.

Evaluation of strawberry genotypes at RHRS, Narsingdi

Four strawberry germplasm viz., FA Nar-075, FA Nar-076, FA Nar-077 and FA Nar-078 were evaluated at RHRS Narsingdi against BARI Strawberry 1. Number of fruits per plant in FA Nar-076 was higher than that of other germplasm. The highest individual fruit weight recorded in germplasm FA Nar-078 (21.45 g).The highest Total Soluble Solids (12.1%) was recorded in germplasm FA Nar-075 and FA Nar-076. Fruit size, fruit weight and fruit yield/plant were recorded higher in FA Nar-078.

Performance of Tisa germplasm in the hilly region

Five germplasm of Tisa fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The maximum number of fruits (167), weight of fruits (20.15 kg) was obtained from the germplasm PC Ram-003 and TSS was also recorded the highest (22.5%) in PC Ram-003 followed by PC Ram-005 (22.4%). The result indicated that the line PC Ram-003 showed better performance. The line is under process to release as a variety.

Propagation Technique

Performance of *In- situ* grafting in jackfruit

The experiment was conducted at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur during 2009-15 to study the performance of *In-situ* grafting on growth and yield of jackfruit. Three germplasm (BARI Kanthal 1, AH Joy-0 99 and AH Joy-115) were tested against seeded jackfruit plant of BARI Kanthal 1. *In- situ* grafting of 3 germplasm was done in 2008. Planting distance was maintained 6 m x 6 m. Changes in both plant height and base girth in every year increased steadily from the very young stage to fruiting stage. Male inflorescence in grafted plant was observed after 3 years of grafting whereas in seeded plant it was observed after 6 years. The plant height in *In-situ* grafted BARI Kanthal 1 was observed more than other germplasm. This might be due to its nature of upward growth pattern. In-situ grafted jackfruit germplasm AH Joy-099 and AH Joy-115 produced female inflorescence after 5 years and BARI Kanthal 1 after 6 years of grafting. Grafted BARI Kanthal 1 and seeded BARI Kanthal 1 produced fruit in the year of 2015. The number of fruits in grafted BARI Kanthal 1 was 7.

Performance of grafted and seedling plants of BARI Kanthal -2

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2014-15 to observe the performance of grafted and seedling plants of BARI Jackfruit- 2. Average plant height (4.56 m), number of branchs/plant (14), base girth (45.67 cm), leaf number and leaf size were found from grafted plant in May 2015. In case of seedling plant, average plant height (6.62 m), number of branch/plant (15), base girth (59.33 cm), leaf number and leaf size were recorded in same date.

Effects of time and scion on grafting of litchi

An experiment was conducted at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur during January 2015 to April 2015 to study the effects of time and scion on grafting of litchi. There were two factors in the experiment viz. time and scion of litchi. Scion of 3 litchi germplasm namely BARI Lichu 3, China-3 and Early Bedana were taken for grafting in the months of January, February, March and April. Time of grafting and scion alone and in combination influenced the success of grafting, days required to bud break, number of leaves, leaf blade length and leaf blade width of litchi. The highest success was achieved in January grafting with the scion BARI Lichu 3 (66.7%) followed by China-3 (60.0 %) and Early Bedana (58.3%). The lowest success was observed in Early Bedana in April (21.6%).

Effect of rootstocks on the growth, yield and quality of BARI Kamala 1

Performance of BARI Kamala 1 was studied using different rootstocks at the Citrus Research Station (CRS), Jaintapur, Sylhet from June 2012 to July 2013. The rootstocks used in the experiment were Rangpur lime, Rough lemon, Kata jamir, Askar jamir, Pummelo and Cleopatra mandarin. The plants were planted in July 2012. Among the rootstocks rough lemon was found satisfactory in case of all the parameters studied.

Effect of different rootstocks on the growth and yield of BARI Satkara-1

Three rootstock viz. Pummelo, Rongpur lime and Rough Lemon were selected for rootstock trial of satkara. The highest plant height (169.33 cm) and base girth (6.33cm) was found from Rongpur lime rootstock. Canopy size was bigger in case of rough lemon rootstock. Pummelo rootstock produced the highest number of branches/plant while leaf size was maximum in rough lemon rootstock.

Effect of time and methods of vegetative propagation in bel

An investigation was carried out at the RARS, Ishwardi, Pabna in 2014 to find out the optimum time and method for vegetative propagation of bel in RCBD design with 3 replications. Six propagation methods viz. splice grafting, cleft grafting, veneer grafting, patch budding, stem cutting and air layering were used at second week of each month from April to August. June was appropriate for all propagation methods in terms of success and growth parameters showing superiority compared to other four months. Cleft grafting gave the highest success 87.67 and 82.33% while veneer grafting showed 85.33 and 80.00% success at 30 and 90 days after propagation, respectively. Veneer grafting resulted maximum number of shoot (3.52), shoot length (12.32 cm) and number of leaves (16.25) at 90 days after grafting. Veneer grafting in the month of June was found the most suitable for successful vegetative propagation of bel.

Performance of grafted and seedling plants of BARI Bilati Gab 1

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2014-15 to observe the performance of grafted and seedling plants of BARI Bilati Gab 1. Average plant height (1.17 cm), number of branches/plant (8.50), base girth (16.2 cm) were found from grafted plant in May, 2015. In case of seedling plant, average plant height (3.35M), number of branches/plant (22.6), base girth (23.8 cm) were recorded in same date.

Effect of IBA and time on air layering of rambutan

The effects of IBA and time of layering on success and survivability of rambutan was investigated in Pomology Division, Horticulture Research Centre, BARI, Gazipur during the year 2014-2015. Trials were conducted in four different month, viz. March, May, June, and September using four levels of Indole Butyric Acid (IBA) as the rooting hormone viz. 1500, 3000 and 4500 ppm. Untreated layers served as control. Result revealed that IBA enhanced the root initiation and induced rooting in a shorter duration. Air layering trials in September and March operation under 1500 and 3000 ppm IBA treatment exhibited maximum rooting percentage. The percent success after transplanting was found higher in May and July operation. Layering of rambutan in the month of March and September exhibited higher rooting on the other hand May and July exhibit higher success**.**

Cultural Management

Split application of fertilizer on grafted jackfruit plant

An experiment was conducted at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2014-15 to study the effects of split application of fertilizer on grafted jackfruit plant. All the treatments produced fruit. The treatment NPK (600-260-600 g/plant) produced the highest number of fruit (10.66) and the lowest number of fruit was found in only Cow dung 20 Kg/plant (2.66). The total fruit yield per plant was significantly influenced by different fertilizer treatment. The highest fruit yield per plant) (63.10 Kg) was recorded in the treatment NPK (600-260-600 g/plant) followed by NPK 750-320-750 g (43.64 Kg). The lowest fruit yield per plant was obtained in only Cow dung 20 Kg/plant (13.30 Kg).

Effect of fertilizer on flower and fruit drop in mango

The experiment was carried out to investigate the effects of fertilizer on flower and fruit drop in mango at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2014 July 2015. BARI Mango-3 was included in the study as variety. Three doses of fertilizers i.e. 100 % [N: 230.41 g, P: 50.00 g K: 100 g, S: 35.97 g, Zinc: 3.60 g and Boron: 3.40 g], 175 %, 250 % of the fertilizer dose and control (no fertilizer) along with 4 irrigations at an interval of 15 days starting from full bloom in each treatment were included in the study. Maximum number of panicles per plant (268.50) was manifested in the plants treated with 250 % of the fertilizer dose + 4 irrigations at an interval of 15 days starting from full bloom. The highest fruit retention per panicle at harvest was recorded in the plants treated with 250 % of the fertilizer dose (1.18), which was statistically at per to that of 175 % of the fertilizer dose (1.13). Control plants always gave minimum number of fruits per panicle and it was recorded 0.46 at harvest. The plants treated with 250 % of the fertilizer dose + 4 irrigations at an interval of 15 days starting from full bloom recorded maximum number of fruits per plant (208), fruit weight (210.54), edible portion (74.69 %) and yield (42.89 kg/plant).

Organic production of mango

An experiment with three organic fertilizers i.e. vermicompost, tricocompost and cowdung along the control (no fertilizer) was carried out to produce safe and quality fruit at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur during September 2014 to July 2015. Regardless of treatments organic fertilizers resulted in higher panicle length over control. Cowdung resulted in maximum number of fruits set per panicle (24.23) and control had minimum fruit set (15.97). All the organic fertilizers manifested higher fruit set at harvest compared to control (no fertilizer). Organic fertilizer, the vermicompost manifested higher number of fruits (71) compared to control (38.00), although all the organic treatments resulted in higher number of fruits over control. Fruit weight in all the treated plants were recorded higher compared to that of control. Cowdung (674.81 g) produced the biggest fruit compared to control (361.83 g). Organic fertilizers manifested higher TSS over control. Maximum and identical yields were noticed in the treatments vermicompost (37.62 kg/plant) and cowdung (35.49 kg/plant). Minimum yield (13.10 kg/plant) was noticed in control plants.

Effect of fruit bagging on different mango varieties grown at Chapainawanganj

An experiment on fruit bagging was conducted at the Regional Horticulture Research Station, BARI, Chapainawabganj during 2014-15 for producing quality mango with minimum application of pesticides. Mangoes were susceptible to different insect-pest and diseases. In this experiment seven BARI released varieties and 4 commercial cultivars were evaluated to improve fruit quality as well as to increase the production of exportable mangoes. The fruits were bagged 40 days after fruit set of each germplasm. Three treatments were used viz.T_1: brown colour double layered paper bag, T_2: white color single layer paper bag and T_3: control (no bag). Double layered brown colour paper bag changed fruit color to all. In all cases good quality, disease and insect free fruits were harvested. These results indicated that fruit bagging could improve fruit quality through reduction in disease and insect-pest attack and increase TSS (%) and shelf life of mango.

Optimization of maturity indices of mango germplasm

An experiment on optimization of maturity indices of some coloured mango germplasm was conducted at the Regional Horticulture Research Station, Chapainawabganj during 2014-15. Mango as a climacteric fruit is frequently harvested when less than fully ripe. This is often necessary to obtain optimal eating quality at the time of consumption where markets are a considerable distance or export from the place of harvest. Majority of mangoes grown at Chapai Nawabganj and Rajshahi districts are either sold locally at low price or lost due to poor transportation and storage. Maturity indices of BARI released varieties and commercial mango cultivars were studied to reduce post-harvest losses or getting optimal eating quality. In addition optimum date is important for the extension of shelf life. Maturity indices indicated that the optimum date of harvesting. BARI released varieties such as BARI Aam 1, 2, 3, 4, 6, 7, 8 and commercial cultivars Gopalbhog, Khirsapat, Langra, Fazli and Ashwina were 94, 102, 112, 118, 114, 117, 118, 88, 96, 103, 117 and 135 days after fruit set, respectively.

Effects of fertilizers on internal breakdown of BARI Aam 3

An experiment was conducted on effects of fertilizers on jelly seed of mango at the Regional Horticulture Research Station, BARI, Chaplain Nawabganj during July 2014- July 2015. The plants were fertilized with four treatments vis. T_1: Control (no fertilizer), T_2: Dolomite @ 15 kg/tree, T_3: Recommended dose (Urea, TSP, MOP, Gypsum, ZnSO4, Boric acid and Cow dung @ 1500 g/tree, 750 g/tree, 450 g/tree, 400 g/tree, 90 g/tree, 40 g/tree and 35 kg/tree) and T_4: Gypsum @ 7 kg/tree. The maximum (8.89) and minimum (6.85) number of leaves were recorded in T_4 and $T_{1,}$ respectively. The maximum leaf area (81.26 cm) were observed in T_3; where the lowest value of leaf breadth (4.10 cm) and leaf area (60.48 cm) were recorded in T_4.The highest length (32.97 cm) and breadth (19.94 cm) of panicles were observed in T_4, where the lowest length (25.31 cm) and breadth (13.86 cm) of panicles were noted in T_1. Highly significant variations were recorded in case of initial fruit setting on 19 March, where T_3 showed the maximum (19.42 fruits/ panicle) fruit setting and T_1 exhibited the minimum (11.78 fruits/ panicle) fruit setting. Maximum number of fruits dropping occurred at first 12 days and then the second highest number of fruits dropping occurred at next 12 days (24^{th} day). Initially, T_3 exhibited the highest (19.42) number of fruit retention and T_1 exhibited the lowest (11.78) number of fruit retention on 19 March. But T_4 showed the highest (0.94) number of fruit retention and T_2 showed the lowest (0.43) number of fruit retention on 6 July (109th day). In case of harvested mature fruit weight, length, breadth and thickness were noted maximum in T_3 (207 g, 10.13 cm, 6.52 cm and 5.90 cm, respectively) and minimum in T_1 (160.02 g, 8.76 cm, 5.89 cm and 5.45 cm respectively). T_3 had the maximum (17.97%) and the minimum (16.13 %) TSS content was noted in T_4 on mature mango, where at harvested ripe mango T_4 had the maximum (17.87%) and the minimum (16.47 %) TSS content was noted in T_3. Shelf life ranged from 10.15 days (T_2) to 7.75 days (T_1). Mature harvested mangoes were less affected by jelly seed than ripe harvested mangoes. Mature harvested mangoes showed the lowest jelly seed in T_4 (0.00%) but the highest in T_1 (20%). On the other hand, ripe harvested mangoes exhibited the maximum jelly seed in T_1 (60%) but the minimum in T_2 (26.93%). A new problem was arise on both cases due to the effect of T_2 (Dolomite), 22.81% mangoes affected by the spongy tissue in ripe harvested fruits and 6.67% mangoes affected by spongy tissue in mature harvested fruits, 6.67% mangoes also affected by spongy tissue due to the effect of T_4 (Gypsum) on ripe harvested fruits. The highest yield per plant was obtained from T_4 (93.39 kg/ plant) as against the lowest in T_1 (20.06 kg/ plant).

Effect of irrigation and mulching on water use efficiency in banana

An experiment to investigate the effects of irrigation and mulching on water use efficiency of banana was carried out at the Fruit Research Farm of Pomology Division, HRC, BARI, Gazipur during the period from October 2013 to December 2014. Plant height was noticed higher (191.83 cm) when straw mulch was rendered to the plants compared to that of control. Total number of leaves was manifested higher in the mulching treatment. Regardless of intervals irrigation treatments took minimum days to shooting and days from shooting to harvest compared to un irrigated control plants. Plants irrigated at 10-day intervals resulted in the tallest plant (194.33 cm) and maximum total number of leaves at shooting. Plants irrigated at 20-day intervals had the highest number of suckers at shooting (5.92) compared to un irrigated control (4.58). The highest number of suckers per plant was observed in the treatment irrigation at 30-day intervals (6.42) as against minimum number of suckers (5.17) in the control plants. Irrigation at 30 day intervals (309.67) combined with mulching with straw took minimum days to shooting followed by irrigation at 10-day (327.33) and irrigation at 20-day intervals (346.67). Irrigation at 10 day intervals combined with straw mulch showed maximum plant height (207 cm) at shooting. Plants having mulch with straw resulted in higher weight of bunch, diameter of bunch, length of fingers, diameter of finger, individual finger weight, wt. of peel per finger and yield compared to those of no mulch treatment. Mulching with straw produced higher yield (36.35 t/ha) compared to no mulch (34.05 (t/ha). Irrigation at 10-day intervals rendered superiority regarding all the characters mentioned above over control and rest of the treatments. Irrigation at 10-day intervals manifested maximum yield (40.67 (t/ha) compared to no irrigation (27.53 t/ha). Weight of bunch ranged from 12.06 to 19.59 kg, where no irrigation combined with no mulch had minimum and irrigation at 10 day intervals combined with straw mulch had maximum bunch weight. Yield varied from 26.79 to 43.53, where no mulch in combination with no irrigation resulted in minimum yield and irrigation at 10-day intervals along with straw mulch exhibited maximum yield.

Influence of integrated fertilizer application on the yield of banana

The experiment was conducted at the HRC research field of RARS, Hathazari, Chittagong during 2014-15. The highest individual finger weight was observed in T_2 (115 g) and T_3 (113 g) as well as maximum number of fingers per bunch were found in T_1 (129). The highest yield per plant was in T_1 (11.6kg) and T_3 (12.5kg) and the highest yield per hectare was in T_1 (19.88t) and T_3 (21.43 t). The treatment T_3 (0%) was free from panama disease and T_1 (0%) was free from leaf blight and anthracnose disease. V_2 (BARI kola 4) is free from panama disease and leaf blight is lower in V_1 (BARI kola 3). The highest individual finger weight was observed in T_3V_1 (131.67g) and T_2V_1 (127.67g) followed by T_4V_1 (120.67g). The total number of fingers was the highest in T_1V_2 (130) and

T_1V_1 (127) followed by T_3V_2 (124). The highest yield per hectare was observed in T_3V_1 (22.5 t) followed by T_2V_1 (21.47 t), T_3V_2 (20.37t), T_1V_2 (20.13 t). Panama disease did not found in T_1V_2, T_2V_2, T_3V_1, T_3V_2, T_4V_2 and T_1V_1, T_1V_2, T_3V_1, T_4V_1 were free from leaf blight disease. All the treatments free from bunchy top disease except T_1V_1 (5.7%).

Effect of different doses of herbicide paraquat 24% SL (Tabara 20 SL) to control weed on banana field

A field trial was conducted at the Fruit Research Farm of BARI, Joydebpur, Gazipur, during the period from January to July 2015 to find out the optimum dose of herbicide to control weed in the banana field. Five treatments i.e. T_1: spraying of herbicide Tabara 20 SL (Paraquat 24% SL) @ 2.00 ml / litre of water; T_2: spraying of Tabara 20 SL @ 3.0 ml / litre of water; T_3: spraying of Tabara 20 SL @ 4.0 ml / litre of water; T_4: Two hand weeding at 25 & 50 DAE (Days after Establishment) and T_5: no spray (Control) were included in this study. Results showed that number of weed/m^2 and weed control efficiency (WCE) were influenced by different weed management methods. The highest (127 and 238) weeds/m^2 were recorded in control plot at 25 & 50 DAE, respectively. The lowest 27 weeds/m^2 were recorded in T_2 followed by T_3 treatment (28) respectively. The highest weed control efficiency 82.96% and 83.60 was found in T_2 treatment at 25 DAE followed by T_3 treatment (82.35% and 82.40%) in field-1 and field-2. The results revealed that spraying of herbicide (Tabara 20 SL @ 3.0 ml / litre of water) was most effective in controlling weeds upto 20-25 days of herbicide spraying. The herbicide action was shown quickly after spraying one day.

Study on the pollen viability of litchi during preservation

An experiment was carried out at the Pomology Division, Horticulture Research Center, BARI, Gazipur during the flowering season of 2015 to study the pollen viability of litchi during storage. Male flowers of BARI Litchu 1 were collected at anther dehiscence stage; time between 8 and 10 a.m. Collected pollens were stored at 4 different storage conditions such as; at room temperature (25-30^{0}C) in petridish, at room temperature in desiccators, refrigerator (5-7^{0}C) and deep freeze (-20±2^{0}C). Fresh pollen showed 43.28% viability, which had 30.06% viability after 7 days of storage in petridish. After 7 days of storage, 29.76% viable pollen was noticed when pollen was stored in desiccator at ambient temperature. Pollen viability under refrigerated condition lasted up to 60 days and it was observed 20.77. At deep freeze (-20±2^{0}C) condition, pollen remained viable up to 60 days which was 31.20%. Pollen viability was tested through *in-vitro* germination for all the storage conditions. Deep freeze stored pollen remained viable up to 60 days, which exhibited 29.84% germination at the same condition.

Effects of bagging on the harvesting period of litchi

An experiment on the effects of bagging on the harvesting period of litchi was carried out in the Fruit Research Farm of Horticulture Research Centre, Joydepbpur, Gazipur during the fruiting season of 2015. Seven treatments included Chorphenoxy Acetic Acid spray and bagging. Treatments were used for this study-T_0: Control, T_1: Spray and open, T_2: Spray and cotton bag, T_3: Spray and white bokrom bag, T_4: Spray and black adhesive-bonded brown paper bag, T_5: Spray and without adhesive bonded brown paper bag and T_6: Spray and transparent poly bag. First harvesting of fruit was done on 10 May in the treatment with cotton bag and spraying Chlorphenoxy Acetic Acid (T_2) and the last harvest was done on 24 May in treatment spray and black adhesive bonded brown paper bag (T_4). Ripening was enhanced 7 days earlier by the panicle bagging with cotton bag and delayed 7 days with the black adhesive-bonded brown paper bag in respect to normal harvesting time (mid May).

Integrated plant nutrient system for mandarin production

The experiment was conducted at Citrus Research Station, BARI, Jaintiapur, Sylhet, from December, 2013 to November, 2014. Mandarin variety BARI Kamala 1 was used for the study. Maximum number of fruits was obtained from 60% RD as per STB from Chemical fertilizer + 40% from Cow dung (50) followed by 80% RD as per STB from Chemical fertilizer + 20% from Cow dung (42). The highest weight of fruits per plant was obtained from 60% RD as per STB from Chemical fertilizer + 40% from Cow dung (3.33kg). This treatment also produced the highest yield (3.76 t/ha) which was statistically identical to that (3.48 t/ha) obtained by 80% RD as per STB from Chemical fertilizer + 20% from Cow dung. Maximum fruit size was obtained from 125% RD as per STB (5.2×5.27 cm) followed by 80% RD as per STB from Chemical fertilizer + 20% from Cow dung (4.97×5.20 cm). Highest percent TSS was found from 125% RD as per STB (8.4%) followed by 80% RD as per STB from Chemical fertilizer + 20% from Cow dung (8.33%) In case of edible portion maximum 75.97% was recorded in Existing Practice (CD) followed by 60% RD as per STB from Chemical fertilizer + 40% from Cow dung (74.20%) and 80% RD as per STB from Chemical fertilizer + 20% from Cow dung (71.86%). Considering all the parameters, 80% RD as per STB from Chemical fertilizer + 20% from Cow dung and 60% RD as per STB from Chemical fertilizer + 40% from Cow dung may be considered as the best integrated nutriment dose for mandarin production.

Effects of gibberellins on seedlessness of grape

An experiment was conducted to examine the effect of GA_3on seedlessness of grape at Regional Horticulture Research Station, Narsingdi during December 20014 to May 2015. GA_3 at the rate of 50 and100 ppm were applied on floral buds before 10 days of anthesis. Both the concentrations of GA_3 induced seedless fruit development. Cluster receiving 50 and 100 ppm concentration of GA_3 produced berries without any seeds inside. Fruit sets were maximum when floral buds were sprayed with 50 ppm GA_3. Berries harvested from cluster receiving GA_3 @ 50 ppm were sweeter than those of 100 ppm. Berries harvesting from control were seeded and sour. GA_3also influenced berries eight and size.

Influence of planting time on growth and yield of strawberry in Narsingdi region

A field trial was conducted to determine the optimum planting time of straw berry at Narsingdi region during October 2014 to March 2015. Four planting dates starting from 1 October 2014 with an interval of 15 days were tested on growth and yield of BARI Strawberry 1. Leaf number at first flowering time (37.67), leaf length (9.00 cm), leaf breadth (14.2 cm) and plant spreading (EW 36.22 cm and NS 36.44 cm) were higher when planted in 1st October 2014. Highest per plant yield (700.79g) as well as yield/ha (23.36t) were obtained from 15th October planting followed by 1st November planting (625.67g and 20.16t, respectively). The lowest yield/plant (230.94g) and yield/ha (7.70t) were recorded from 15th November planting. Total soluble solids (TSS) of fruits were significantly higher (11.39%) in fruits harvested from plants of 1st October.

Disease Management

Survey of floral malformation of mango in major mango growing regions of Bangladesh

The study was conducted to assess the prevalence and severity of mango floral malformation during March to April 2015. Fifty locations were visited in five Upazillas of Chapai Nawabganj districts with the objectives to confirm the status and update the existing statistics for the future planning and management. The disorder was found widely distributed. The maximum severity (6.65%) was observed in Gomostapur Upazilla followed by Nichol (6.21%). All the traditional cultivars were more or less affected. Among the varieties the highest severity (15.53 %) was recorded from Ashwina followed by BARI Aam 3 (13.78%). Ashwina and BARI Aam 3are moderately susceptible (MS) while BARI Aam -1, Fazli and Mullica are moderately resistant and others are tolerant variety to the malady.

Integrated management of post harvest anthracnose and stem-end rot of mango

A field trial was conducted at the Regional Horticulture Research Station, Bangladesh Agricultural Research Institute, Chapai Nawabganj during May to June, 2015 to evaluate the effect of different treatments against post-harvest anthracnose and stem-end rot of mango fruits. Among the treatments significantly the highest disease reduction was observed in integrated approach with Baiting DF and harvesting with one inch stalk compared others.

Incidence of mango scab disease and its management

A field trial was conducted at the Regional Horticulture Research Station, BARI, Chapai Nawabganj during February to June, 2015 to find out the reaction of eleven most popular mango varieties against the disease and to find out the suitable fungicide to control the disease. Among the varieties the highest incidence (24.50% & 43.12%) and severity (4.90% & 13.15%) was recorded in Khirsapat. The lowest disease severity (3.53%) as well as the highest disease reduction (87.53%) was recorded from fruits treated with Iprozim 26 WP.

Efficacy of new fungicides in controlling anthracnose of mango fruits

A field trial was conducted at the Regional Horticulture Research Station, BARI, Chapai Nawabganj in Bangladesh during February to July 2014, to test the efficacy of 27 new fungicides against post-harvest anthracnose of mango fruits. None of the fungicides under investigation was able to control the disease completely. Out of 27 fungicides Palki 75 WG (Tebuconazole + Trifloxobin), Fuji SC (Dificonazole + Azoxystrobin), Nativo 75 WG (Tebuconazole + Trifloxobin), Ecozole 10 EC (Hexaconazole) and Rodazim 50 WP (Carbendazim + Iprodazim) were the best fungicides to control postharvest anthracnose. Among the fungicides five fungicides i.e. Zole plus (Dificonazole + Propiconazole), G- force 5 EC (Hexaconazole), Durjoy 300 EC (Dificonazole + Propiconazole), Sinmaze 80 WP (Mancozeb) and Sunzoxy (Azoxystrobin + Tebuconazole) were not able to control more than 80 % of the disease. But rest of the fungicides was able to control more than 80 % of the disease.

Survey and identification of causal pathogen of black spot of litchi at Rajshahi region

A survey was conducted at Rajshshi region including Ishurdi (Pabna) during 2014-15. After isolation, identification and pathogenicity test it was confirmed that causal agent of black spot/brown spot of litchi was Colletotrichum sp. The highest percent diseases incidence was found in early variety BARI litchi 1 compare to bombai and averagely diseases incidence was found 7.35%.

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, neemextracts was found effective followed by Bavistin and Tilt fungicides against Pestalotia spp. of coconut.

Survey on the occurrence of diseases of golden apple (*Spondias dulcis*) in Barisal region

A multi-disciplinary team of researchers (Plant Pathologist and Entomologist) from Horticulture Research Centre, BARI, Gazipur was conducted a survey in Jhalkathi and Pirozpur districts. Golden apple fruit was found highly susceptible to gummosis in all areas. The older plant was more infected than younger plants. The highest incidence recorded in gummosis (80%) followed by shooty mold (40%) and dieback (15%) at Pirozpur district.

Survey of diseases of citrus

A survey program was conducted on disease incidence of citrus during 2014-2015 seasons in Shibpur Upozilla at Narshingdi. Total 201 plants were visited where the incidence of gummosis and dieback was found 12% and 8.46%, respectively**.** The incidence of greening and scab were also noticed, the incidence was found 11.94% and 2%, respectively**.**

Collection and identification of strawberry diseases

Disease samples of strawberry were collected from fruit research fields, HRC, BARI, Gazipur during October 2014 to May 2015 at different growth stages of strawberry to identify the diseases. Disease symptoms appeared on fruits, leaves; crown and stem were collected and cultured on PDA media. *Fusarium* sp, *Colletotrichum* sp., *Aspergillus* sp., *Penicillium* sp. and *Alternaria* sp. were identified from leaves and fruits. *Colletotrichum* sp. was identified in sucker and fruits. Parasitic nematodes were recorded in roots and rhizosphere soil samples.

Insect-Pest Management

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 during February - March 2015 to know about the pollinator visited the mango orchard during flowering stage. The survey of insect species visiting mango flowers indicated that the highest number of species were from order Diptera (flies), 4, then Hymenoptera (ants, bees, wasp),1. The insect population (number/100 panicle) was the highest 38.92 of Syrphid fly, in decreasing order of population were Ant (14.46), House fly (8.23), Blowfly (3.69) and Flower fly (2.69). 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 fruits were observed in 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 during February-April, 2015 to know about the pollinator visited the litchi orchard during flowering stage. 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 1.73 of Syrphid fly and flower fly in decreasing order of population were Honey bee (0.63), House fly (0.02) and Blow fly (.02). In Bombai litchi the highest 2.34 of Honey bee in decreasing order of Flower fly (0.98), Syrphid fly (0.47), Blow fly (0.06) and House fly (0.02). In Dinajpuri litchi the highest 2.33 of Honey bee in decreasing order of Syrphid fly (0.36), Flower fly (0.26), Blow fly (0.07) and House fly (0.02). The highest number of insect was observed as a pollinators/visitor at the first half of the day.

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 2014 to know incidence, nature and extent of damage and effect of different control measures. Five different control approaches viz. 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 (96.66%) 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 43.33% 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 (55.17% 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)

Susceptibility of different varieties of litchi to litchi mite (*Aceria litchi* KEIFER)

An experiment was conducted at Fruit research station,BARI, Binodpur, Rajshahi duuring 2014-15 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 13.77% leaves 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 3.04% infestation found in Dinajpuri.

Efficacy of different control measures against litchi mite (A*ceria litchi* KEIFER)

The experiment was conducted at Fruit research station, Binodpur, Rajshahi duuring 2014-15 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. To control the litchi mite there were five treatments among them lowest leaf infestation (5.21 %) was observed from T_1 = pruning of infested foliage + one spray of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5ml /liter of water) with 85.19% infestation reduction over control which is statistically different from other treatments and the highest leaf infestation (35.19 %) was observed from T_5 (Untreated control). Other treatments ranged from 7.72 – 13.31 per cent leaf infestation with 62.17-78.06% infestation reduction. In case of per cent infested inflorescence lowest infested inflorescence (2.82 %) was also observed from T1 with 72.11% infestation reduction over control followed by T_2 (3.51 %) and T_3 (3.82 %). The highest value of per cent infested inflorescence was observed from T_5 (10.11 %) which differed statistically from other treatments. The number of fruits was maximum in treatment T_1 (920000/ha) and lowest in treatment T_5 (506000/ha). Highest gross margin was noticed in T_1 (1869560) and lowest in T_5 (1113200). The highest MBCR was found in treatment T_2 (5.20) and lowest in T_4 (3.67).

Soil and Water Management

Effect of urea super granule (USG) with different levels of poultry manure (pm) and cowdung on the yield and quality of banana

The experiment was conducted at the Horticultural Research Farm, BARI, Joydebpur, Gazipur during year 2013-2014. A three levels of organic manure as i) 1.2 kg plant $^{-1}$ (3 ton poultry manure ha^{-1}); ii) 2 kg plant $^{-1}$ (5 ton poultry manure ha^{-1}), and iii) 2 kg plant $^{-1}$ (5 ton cowdung ha^{-1}) and in factor B four levels of chemical fertilizer doses were as i) Recommended dose of fertilizer N as PU: $N_{230}P_{80}K_{300}S_{36}Zn_{16}B_3$ plant^{-1} ; ii) Recommended dose of fertilizer N as USG: $N_{230}P_{80}K_{300}S_{36}Zn_{16}B_3$ plant^{-1} ; iii) 85 % recommended dose of N as USG: $N_{195}P_{80}K_{300}S_{36}Zn_{16}B_3$ plant^{-1}; iv) 70 % recommended dose of N as USG: $N_{161}P_{80}K_{300}S_{36}Zn_{16}B_3$ plant^{-1} were considered as treatments. From one year 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. Cow dung @ 5 ton/ha with 85% recommended USG (A_3B_3) followed by followed by 5 ton CD with recommended USG (A_3B_2) showed the better yield and quality banana production.

Effect of irrigation and mulch on the yield of strawberry

This study was conducted at the experimental fields of Pomology Division, BARI, Gazipur and ARS, Burirhat, Rangpur during Rabi season of 2012-13 to 2014-15 to investigate the effect of irrigation and mulch on the yield of strawberry (BARI Strawberry 3). The experiment was conducted followed by split plot design with two mulchs and three levels of irrigation and three replications i.e. M_1I_1, M_1I_2 and M_1I_3 are the irrigation up to field capacity (FC) at 5, 10 and 15 days interval after plant establishment (PE) with black polythene mulch, respectively and M_2I_1, M_2I_2 and M_2I_3 are the irrigation up to FC at 5, 10 and 15 days interval after plant establishment (PE) with straw mulch. In Joydebpur, the results showed that most of the yield contributing parameters like plant height, no. of leaves per plant, leaves length, days to 50% flowering, days of 1st harvest, no. of fruits per plant, individual fruit weight, fruit length and yield except fruit diameter and TSS in the first year and all parameters in the second year were significantly influenced by different irrigation treatments. In case of Burirhat, all parameters in the first year and in the second year, leaves per plant, days to 50% flowering, days of 1st harvest, no. of fruits per plant, fruit length, fruit diameter, and yield were showed significant effect. The highest (11.98 t/ha in the first and 12.30 t/ha in the second year) and lowest (4.84 t/ha in the first and 6.87 t/ha in the second year) yield were observed from the treatment M_2I_1 and M_1I_3, respectively in Joydebpur. Whereas, in Burirhat, the highest (9.56 t/ha in the first and 11.74 t/ha in the second year) yield were observed from the treatment M_1I_1 and lowest (5.94 t/ha and 7.01 t/ha in the first and second year, respectively) were found in treatment M_2I_3 and M_1I_3, respectively. The highest and lowest seasonal water uses were found in treatment M_2I_1 and M_1I_3, respectively for both the years and both locations. So, on the basis of gross return, treatment M_2I_1 in Joydebpur location and treatment M_1I_1 in Burirhat location perform better. But in respect of economic profitability, the highest marginal rate of return was found in treatment M_2I_2 for both the locations i.e. mulching the field with straw and irrigating field at 10 days interval may be effective for the strawberry production.

Response of strawberry to Boron and Zinc fertilization

An experiment was conducted at the research field of Horticulture Research Centre, BARI, Gazipur during rabi season of 2014-2015 to evaluate the response of strawberry (var. Festival) to B and Zn micronutrients and also to find out the optimum dose of boron and zinc for maximizing flower yield of strawberry. Sixteen treatments comprising four levels of B (0, 1, 2 and 3 kg/ha) and four levels of Zn (0, 2, 3 and 4 kg ha^{-1}) along with blanket dose of $N_{115}P_{40}K_{110}S_{25}$ kg/ha were used in the trial. Application of B and Zn and their combination had a profound effect on fruit characters and fruit yield of strawberry. Boron-Zinc integration was appeared to be more responsive than their single application. Number of fruit, length and diameter of fruit, individual fruit weight and yield of fruits were greatly influenced by the application of higher doses of boron-zinc combination and further increase of B and Zn suppressed the fruit production. The maximum number of fruit (12.75/plant), longest fruit length (5.53 cm), highest diameter of fruit (4.18 cm), individual fruit weight (30.50 g) and the highest fruit yield (10.45 t/ha) were recorded with combined application of $B_{2.0}Zn_{3.0}$ kg/ha. The yield of fruits increases due to $B_{2.0}Zn_{3.0}$ kg/ha was 5.57 t/ha which was 114% over control (without B and Zn).

Postharvest Management

Quality of jackfruit bulb as affected by minimal processing

An experiment was conducted to select suitable additives for minimal processing of jackfruit bulb. It was done at the laboratory of Postharvest Technology section, Horticulture Research Centre, BARI, Gazipur during August 2014. The bulbs of ‘Khaja’ type jackfruit were processed minimally by adding different levels of ascorbic acid as T_1= 0.2%, T_2= 0.4%, T_3= 0.6%, T_4= 0.8% and T_5= 1.0% and stored in refrigerator (4±1°C). The fruit was opened, bulbs were separated, seed was removed from each bulb and then bulbs were immersed in solutions of different treatments for three minutes, took out from solution and packed in poly propylene (pp) box. The packets were stored in normal refrigerator at 4 ± 1^0C. The minimally processed jackfruit bulbs were evaluated in respect of shelf life, %TSS, %total sugar, %reducing sugar, % titratable acidity, vitamin C, colour and sensory quality. Treatment T_1 (0.2% ascorbic acid) showed better performance in TSS (29.41^0%). Treatment T_4 (0.8% ascorbic acid) showed better performance in retaining the amount of total sugar (44.37%) and reducing sugar (14.63%) of jackfruit bulbs. The treatment T_3 (0.6% ascorbic Acid) was the best for higher shelf life (12 Days) retaining better color , titratable acidity (0.075%), vitamin C (9.47 mg/100g) and sensory quality (overall acceptance score based on color, taste and flavor 7.2 and sweetness and juiciness score 7.6) at refrigerator (4±1°C).

Postharvest quality response of strawberry using edible coating with refrigerated storage

Strawberries (*Fragaria X ananassa* Duch.) were coated with either chitosan (1%, 1.5% and 2%) solution or Aloe vera (AV) gel and air dried conducted at postharvest Technology Laboratory, HRC, BARI during February 2015. Following treatment, strawberries were kept in to polypropylene box and stored at refrigerator (6±1°C and 50±5% RH). The effectiveness of the treatments in extending fruit shelf-life was evaluated by determining respiration rate, firmness, weight loss, external colour, some chemical parameters (ascorbic acid content, TSS, acidity, P^H) fungal decay, general appearance and sensory quality. Initial ascorbic acid in strawberry was 60.82 mg/100g. At 10th day of storage, ascorbic acid content reduced severely to 40.60 mg/100g in uncoated fruits, while 55 mg/100g in the strawberry coated with Aloe vera gel. Initial acidity and TSS was 0.83 % and 7.5 % respectively. At 10th day of storage, acidity decreased slightly and TSS increased moderately ranged from 9.3% to 10.4%. The incidence of rot started on 6th day in uncoated/ control and 1% chitosan coated fruit. The beneficial effect of chitosan was enhanced when the polymer was applied at a greater concentration. Fruits coated with 1.5% and 2% chitosan affected by fungal decay at 9th day of storage period. On the other hand, rot incidence was initiated in Aloe vera gel coated strawberry at 15th day of storage period. The coating, chitosan or AV gel reduced respiration activity, thus delaying ripening and the progress of fruit decay due to senescence. AV gel or chitosan coatings delayed changes in weight loss, firmness and external colour compared to untreated samples.

Physicochemical responses of mandarin to skin coatings

An experiment was conducted to assess the influence of skin coatings on storage life of mandarin at postharvest Technology Laboratory, HRC, BARI during December 2015. Sorted fruits were washed, air dried and coated with 12% wax, 0.5% chitosan, 1% chitosan, 1.5% chitosan, and 100% coconut oil. After coating, fruits were air dried and kept at ambient condition (25±3 °C, 60–70% RH) and analyzed for various physical and chemical parameters like weight loss, respiration rate, firmness, decay incidence, TSS, P^H, ascorbic acid, and also organoleptic attributes. The results revealed that coconut oil had great effect on the reduction of the weight loss (7.21%) and respiration rate ($6.61CO_2$ml. kg^{-1}.h^{-1}), and preserved firmness (0.41 kg), total soluble solids (9.5%), ascorbic acid (22.4 mg/100 ml juice), total sugar (11.98%) and reducing sugar (4.4%) at 16th day of storage. Fruits coated with coconut oil secured the highest score (8.1, 7.8, 7.4 and 7.8 in case of appearance, flavour, texture and overall acceptability respectively) and significantly superior than other treatments. The incidence of rot started on 4th day of storage in uncoated/ control, 12% wax, 0.5% and 1% chitosan coated fruit whereas, rot incidence was initiated in coconut oil coated mandarin at 16th day of storage period.

Degreening of malta fruit using low-cost ethylene generator

The effect of ethylene gas produced through simple ethylene generator on degreening of malta fruit cv. BARI Malta 1 was investigated at postharvest Technology Laboratory, HRC, BARI during October 2014. Malta fruits were harvested at full mature but green stage and exposed to ethylene gas at 0, 5, 10, 20, 30, 40 and 50 ppm for 24 hours at 20 ± 1 °C. The development of yellow peel colour of malta enhanced significantly by ethylene gas even at lowest concentration of 5 ppm showing the hue value 92° on day 6 of storage. However, ethephon concentration at 20 ppm exhibited the best performance showing complete yellow skin of malta. Both ascorbic acid and TSS contents of malta fruits treated with ethylene gas reduced slightly during degreening process but did not significantly different with fruits under control treatment. The results demonstrate the efficacy of simple ethylene generator on matla fruit and imply prospects for the postharvest application of ethephon at 20 ppm as a source of ethylene gas on green mature malta fruit cv. BARI Malta 1 for developing bright yellow peel colour retaining desired quality and texture.

Efficacy of 1-methylcyclopropene in prolonging the postharvest green life of lemon

The effect of aqueous 1-methylcyclopropene (1-MCP) on postharvest green life and quality of lemon (*Citrus limon*) was investigated at postharvest Technology Laboratory, HRC, BARI. Lemon fruits at the mature green stage were harvested and immersed in aqueous 1-MCP at 0, 300, 500 and 700 µg L^{-1} for 10 min, fan-forced air-dried, placed into 1% perforated low density polyethylene bags and then stored at 12 ± 1 °C and 90 ± 5% RH for over three weeks. Tissue softening, surface colour development and rate of ascorbic acid decrease were delayed in fruit exposed to aqueous 1-MCP. However, delay of senescence was concentration depended, with maximum inhibition in response to 10 min immersion occurring at higher concentrations of 700 µg L^{-1}. The changes of tissue firmness was strongly suppressed in lemons treated with 700 µg L^{-1}1-MCP compared to fruits under control treatment and maintained firmness of 5.85 kg f at the end of 21 days of storage. The loss of firmness in control fruit was recorded by 44.3 %, whilst it was about 22 % in fruit treated with 700 µg l^{-1} 1-MCP. Moreover, losses of ascorbic acid content and surface green colour of lemons treated with 1-MCP significantly delayed and consequently extended at least seven days extra storage life compared to fruits under control treatment. In contrast, more than 59% lemons under the control treatment became yellowing after 21 days of storage, when the surface hue, tissue firmness and ascorbic acid contents rapidly decreased and reached to 105.6, 4.25 kg f and 22.1 mg $100g^{-1}$, respectively. The results demonstrate the efficacy of relatively short exposure to aqueous 1-MCP on lemon fruit and imply prospects for the postharvest application of 1-MCP at 700 µg L^{-1} for prolonging the green life of lemons up to 21 days at 12 ± 1 °C and 90 ± 5% RH.

Storage stability of oven dried jackfruit leather

An experiment was conducted to study the storability of oven dried jackfruit leather affected by packaging materials at postharvest Technology Laboratory, HRC, BARI. Jackfruit leather was prepared from fully ripe fruit. Freshly prepared leather scored between 2 (Like very much) and 3 (Like moderately) while organoleptically evaluated. Three types of packaging materials (poly propylene, high density poly propylene and laminated aluminum foil) were used. The samples in all packaging did not show much change in colour compared to freshly prepared samples for a period of 30 days but showed higher rate of moisture gain. The pH value decreased with the increase of storage period. At the end of storage period (60days) β-carotene contents were 14.2, 15.17 and 17.4 for the samples packaged in PP, HDP and LAF, respectively. The highest amount (2.2%) of vitamin-C losses was observed in the sample packaged in PP followed by HDP (1.67%) and LAF (1.3%), respectively. During the storage period, content of titratable acidity of the leather in different packaging materials increased (Fig.7). At the end of the storage, leathers packed in PP, HDP and LAF contained 1.68, 1.64 and 1.63% acidity, respectively. Reducing sugar of jackfruit leather in all packaging materials increased during storage. After 60 days of storage period reducing sugar content in jackfruit leather packaged in PP was higher (39.1%), than in HDP (38.5%) and LAF (38.2%). Leather kept in laminated aluminum foil (LAF) performed better than those of kept in poly propylene and high density poly propylene pouch.

Socio-Economic Studies

Adoption of BARI Peyara-2 and its constraints to higher production in some selected areas of Bangladesh

The study was conducted in three district namely Natore, Moulavibazar and Gazipur districts. A total of 90 farmers were selected by taking 30 samples from each area. Profitability and adoption of BARI peyara-2 were the main objectives of the study. The results of Natore area were presented in the study. The respondents of other two areas were unable to give fruitful answer to show in results. Most of the farmers of Natore area were aged between 30 to 40 years and they were highly educated among the areas. Lower family size was obtained in this area. Agriculture was the main occupation of the respondents. Other two areas have subsidiary occupation like business. All the farmers of Natore and Gazipur areas cultivated BARI peyara-2. Sub Assistant Agriculture officer and BARI personnel motivated farmers to cultivate this variety. Guava cultivation is a continuous cost intensive technology. To establish a garden of one hectare the farmers had to incur cost Tk 160257. The farmers incurred cost Tk 287857, Tk 370210, Tk 350210 and Tk 308039 for 2nd, 3rd, 4th, and 5th year of cultivation. On the other hand, the farmers got income Tk 548601, Tk 660883, Tk 706054 and Tk 605674 for the mentioned years, respectively. Benefit cost ratios on full cost and cash cost basis about 2, which directed that guava cultivation is profitable. Sensitivity analysis helped farmers to take decision to invest more in establishment of guava garden. The farmers faced some problems like disease and pest infestation, short duration variety etc.

Agroforestry

Performance of different fruits under multi strata cropping system

The experiment was conducted at Fruit Research Farm of HRC, BARI Gazipur to find out the suitable fruit species under the shade of coconut orchard to maximize the production from a piece of land at the same time. Four treatments were included in this study i.e. i. Pineapple + Guava var. BARI Guava-2 ii. Pineapple + Burmese Grape var. BARI lotkon-1 iii. Pineapple + Lime var. BARI lebu-3 and iv. Pineapple + Litchi var. BARI Litchu 3. Growth of guava plants seems to be quicker compared to those of other fruit species. The highest plant height (237 cm) and canopy spread 157 cm (N-S) and 154 cm (E-W) were recorded from the guava plants. Early flowering (mid April 2014) was observed in the guava plants. During the year 2015only pineapples were harvested, among the treatment combination pineapple grown under lotkon produced maximum fruits/plot (17.25) followed by pineapple+Litchi (16.00).

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, BARI, Gazipur during winter season of 2014-2015. There were significant variation among the genotypes in respect of plant height (35-65 cm), number of flowers per plant (16-80), diameter of flower (2.6-8.5 cm), stalk length (4.2-12.5 cm) and vase life of flowers (4-12 days). Among the genotypes, CM-004, CM-022 and CM-025 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

Twenty nine genotypes of gerbera along with BARI Gerbera 1 were evaluated at the Floriculture Field of Horticulture Research Centre, BARI, Gazipur during 2014-15. The results 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

Twenty genotypes of dahlia were evaluated at the Floriculture Field of Horticulture Research Centre, BARI, Gazipur during winter season of 2014-2015. 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

A study was conducted at Floriculture Field, Horticulture Research Centre, BARI, Joydebpur, Gazipur during the period from November 2014 to May 2015 to find out the performances of nine gladiolus genotypes including BARI Gladiolus 1 used as check. It revealed from the study that GL-002, GL-012, GL-031 and GL-037 were 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 2014-2015. 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

A study on the performance of six heliconia germplasm was conducted at Floriculture Farm of HRC, BARI, Gazipur during 2014-2015. 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 seven 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

The genotypes of euphorbia were evaluated at Floriculture Field of HRC, BARI, Gazipur during 2014-15. The results 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 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 cut flowers 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 2014-2015. Marked variations for all qualitative and quantitative characters were observed. Based on flower colour, flower number, flower size and durability of flower, A-001 and A-004 were identified as better genotypes.

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 cut flower 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 2014-2015. 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 better genotypes.

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 2014-2015. 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.

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 season of 2014-2015 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 2.5-7.0; fruit weight ranged from 100-700 g. The range of fruit size was 4.3-11.0 cm. Fruit yield varied from 0.56-1.75 kg per plant. Storage duration was good ranging from 120-180 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 colour, various shapes and large number of florets are on demand of 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, 2014-2015 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.

Influence of different concentration of auxin on propagation of BARI marigold-1

An experiment was conducted at the Poly Vinyl House of Floriculture Field of Horticulture Research Centre, BARI, Gazipur during 2014-2015 to study the influence of three auxins namely indole acetic acid (IAA), indole butyric acid (IBA) and naphthalene acetic acid (NAA) on stem cuttings of BARI Marigold 1 when applied singly or combinedly in different concentrations. It was found that IBA when applied singly at 200 ppm concentration, performed better than other treatments in all the studied characters like rooting percentage, root number, root length, early rooting etc.

Effect of varieties and disbudding on the quality cut flower production of chrysanthemum

An experiment was conducted at the Floriculture Research Field of Horticulture Research Centre, BARI, Gazipur during 2014-2015 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 4 blooms/plant.

Effect of corm size and boron on growth and flowering of gladiolus

The investigation was carried out at the Floriculture Research Field, HRC, BARI, Gazipur from November 2014 to May 2015 to determine the optimum corm size and boron level for quality flower production of gladiolus. The experiment consisted of two factors such as Factor A: corm size (3 levels): small (15.0 g) - S_1, medium (30.0 g) - (S_2) and large (50.0 g) - (S_3) and Factor B: boron (four levels) B_0: Control, B_1: 1.0 kg/ha, B_2: 2.0 kg/ha and B_3: 3.0 kg/ha. The results of the experiment showed that the corm size and boron had significant effect on most of the parameters in gladiolus. Maximum flower yield (202000 spikes/ha) was produced from the large sized corm. All doses of boron significantly improved the yield contributing characters of gladiolus over control, while the most effective dose was 2.0 kg/ha boron. However, the treatment combination of large size corm with the application of 2.0 kg/ha boron performed best in respect of vegetative growth and flowering in gladiolus.

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 among the top ten cut flower 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 gerbera at protective condition was undertaken at Floriculture Division, HRC, BARI, Gazipur during 2014-2015. One month age of tissue cultured BARI Gerbera-2 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

A study was conducted at Floriculture Research Field of HRC, BARI during the winter season of 2014-15 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

The experiment was conducted at the Floriculture field of Horticulture Research Centre, BARI, Gazipur during 2014-2015 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 with 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 the highest yield (15 t/ha) were also recorded in this treatment.

Effect of growth regulators on growth, flowering and corm production of gladiolus

An experiment was carried out to study the effect of growth regulators on growth, flowering and corm production of gladiolus during 2014-15 at Floriculture Field of Horticulture Research Centre, BARI, 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

An experiment was conducted at Floriculture Division of Horticulture Research Centre, BARI, Gazipur, during November 2014 to May 2015 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.

Effect of N, P and K fertilizer on the yield of chrysanthemum

An experiment was conducted at the research field of Horticulture Research Centre, BARI, Gazipur during rabi season of 2014-2015 to evaluate the response of different doses of N, P and K on the yield attributes and yield of chrysanthemum (var. BARI Chrysanthemum-1). Treatments comprising four levels each of N (0, 100, 150 and 200 kg/ha), P (0, 50, 75 and 100 kg/ha) and K (0, 90, 135 and 180 kg/ha) along with blanket dose of B_2 Zn_4 kg/ha were used. The treatments were arranged in a randomized complete block design with three replications. The combined effect of NPK significantly increased yield and yield attributes of chrysanthemum. The maximum flower yield was obtained with the application of N_{150} P_{75} K_{135} kg/ha along with blanket dose of S_{25} kg and B_2 Zn_4 kg/ha. From the regression analysis it was found that the relationship between yield and N, P and K was quadratic in nature.

Effect of N, P and K fertilizer on the yield of marigold

An experiment was conducted at the research field of Horticulture Research Centre, BARI, Gazipur during *rabi* season of 2014-2015 to evaluate the response of different chemical fertilizers (N, P and K) on the yield attributes and yield of marigold (var. BARI Marigold-1). Treatments comprising four levels each of N (0, 60, 90 and 120 kg/ha), P (0, 30, 40 and 50 kg/ha) and K (0, 60, 90 and 120 kg/ha) along with blanket dose of $B_{2.0}$ $Zn_{4.0}$ kg/ha and cowdung 5 t/ha were used. The treatments were arranged in a randomized complete block design with three replications.The combined effect NPK significantly increased yield and yield attributes of Marigold. The highest flower yield was obtained with the application of N_{90} P_{40} K_{90} kg/ha along with blanket dose of S_{25} kg and B_2 Zn_4 kg/ha. From the regression analysis it was found that the relationship between yield and N, P and K was quadratic in nature.

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 2014 to April 2015. The study was set up in CRD with three replications. Marigold 'Inca' was used as plant 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 2014.The study revealed that there was remarkable variation observed among the electrical conductivity levels. 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

A trial was conducted at Sreepur (Gazipur), Sonatola (Bogra), Godagari (Rajshahi), Godkhali (Jessore) and Bodorgonj (Rangpur) during *rabi*, 2014-2015 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 400 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. 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 SOIL MANAGEMENT

Physical aspects of soil management

Determination of crop coefficient values of wheat and leaching loss of nutrients by drainage Lysimeter

A study was conducted in the Lysimeter located at the Central Research Farm, BARI, Gazipur during rabi 2014-15. The objectives were to find out the location specific crop coefficient (Kc) values of wheat and to determine the leaching loss of nutrients. Four regimes of irrigation water were applied on the basis of critical growth stages such as T_1: one irrigation at CRI, T_2: two irrigations at CRI and MT, T_3: three irrigations at CRI, MT and IGF, T_4: four irrigations at CRI, MT, IGF and LGF. The experiment was conducted in completely randomized design with 3 replications. The highest yield (4.87 t ha^{-1}) was obtained from T_4 treatment which was statistically identical to T_3 treatment but significantly lower than rest two treatments. As such Kc values were calculated from T_4. The estimated Kc values of wheat were found to be 0.34, 0.48, 0.33 and 0.16 for initial, crop development, mid season and late season stages, respectively. Such Kc values appeared to be much lower than the FAO recommended one. The probable reason might be the water deficit in between subsequent irrigations as reflected in the depletion of soil moisture storage. Application of water on the basis of critical growth stages might have created water deficit of the crop in between the stages, which could be the reason for getting lower ETc as well as Kc. Irrigation to the micro lysimeter tank should therefore be applied taking reasonable days of intervals encompassing critical growth stages. Thus further trial with revised treatment is need for finding out the location specific standard Kc. Substantial amount of K, Ca, Mg, S, Fe and Mn were lost through leaching. This should be taken into account for ensuring crop nutrition and minimizing ground water pollution.

Effects of tillage methods and residue management on soil properties and yield of potato- maize-T. Aman rice cropping pattern

Field experiments on Potato- Maize-T. Aman rice cropping patterns were conducted in Grey Terrace soil of Gazipur under AEZ-28 and Dark Grey Flood plain Soil of Jamalpur under AEZ-9 during 2013-14 and 2014-15 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. Residue incorporation also brought yield benefit to a considerable extent. 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 31.14 to 41.94 t ha^{-1} at Gazipur while such variation was 34.77 to 45.75 t ha^{-1} at Jamalpur where the highest result 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% and 13% yield benefit over conventional practice for Gazipur and Jamalpur, respectively. The second cycle of the pattern is continuing with fifth crop maize was in grain filling stage till the preparation of the present report. However, residue incorporation could minimize the yield gap between minimum tillage and deeper tillage practices in addition to its beneficial role for sustaining soil health.

Effect of raised bed planting and potassium application on the mitigation of soil salinity and yield of maize

A field experiment on hybrid maize (BARI maize-9) was conducted in coastal saline at Hazirhat, Noakhali under Young Meghna Estuarine Floodplain (AEZ-18) and also at Kuakata, Patuakhali (AEZ-13) during late rabi 2014-15 to reduce salinity damage; increase maize yield and nutrient uptake under salt stress condition; and K dynamics in soil as a function of soil salinity. Four rates of fertilizer K (Native K, 100% STB K, 125% STB K and 150% STB K) were tested under two planting methods (Flat land and raised bed) in a randomized complete block design with three replications. Other nutrients were also applied following STB method. Per sowing 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 (12.16 and 12.46 dS m^{-1}) for flat land and raised bed, respectively. The higher rates of K contributed to 31-44.2% increased yield over control as against 16% with STB dose which implies the necessity of higher dose of K in salt affected soil in augmenting yield. At Kuakata, K application contributed 14.4-29.2% increased yield over K control. Different combinations contributed 16.7-47.7% and 15.6-34.1% yield benefit over K control for Hazirhat and Kuakata, 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 2.6 and 5.1% for Hazirhat and Kuakata, 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.

Effects of different soil moisture regimes and nutrient management on soil physical properties and yield of broccoli

A field experiment was carried out at Research Farm, BARI, Gazipur during 2014-15 to develop irrigation scheduling under given nutrient management options for higher use efficiency and yield of broccoli and to observe 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: STB dose, NM_2: 80% STB dose from inorganic fertilizer + 20% from organic manure, NM_3: 120% of STB dose were arranged in a RCB design with 3 replications. Different soil moisture regime showed significant variations on the yield and yield attributes of broccoli. The significantly highest yield of broccoli (17.8 t ha^{-1}) was obtained from I_3 (IW/CPE ratio=2.00) where the water use efficiency was maximum (0.8 cm^{-1}). The lowest yield (9.2 t ha^{-1}) was found in I_1 (IW/CPE ratio=0.50). Among the nutrients, IPNS approach based dose of fertilizers gave the significantly highest yield (14.5 t ha^{-1}) of broccoli, which was statistically similar (14.4 t ha^{-1}) to 120% STB based dose and the lowest yield (13.7 t ha^{-1}) was obtained from STB fertilizers dose using present recommendation. Thus IPNS dose seemed may be useful in saving the need of 20% chemical fertilizers.

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 Research Farm at Gazipur (AEZ-28) and at RARS, Jessore (AEZ-11) during the rabi season 2014-15 with an aim to observe the suitable dose of compost and chemical fertilizers for maximizing the yield and the effect of tillage methods and compost based IPNS package on the improvement of soil health under the cropping pattern Radish-Pea-Okra-T. Aman rice. 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. NM1= 100% STB (based on FRG, 2012) all from chemical fertilizer, NM_2= 125% STB (FRG, 2012) all from chemical fertilizer, NM_3: NM_1 (75% from chemical fertilizer + 25% from compost) and NM_4: Native fertility. The highest root yield (23.5 and 20.0 t ha^{-1}) of radish was recorded from deep tillage, which was significantly higher over conventional tillage and minimum tillage (4-6 cm depth). Radish responded significantly to different nutrient management packages. The highest root yield (26.2 and 19.9 t ha^{-1}) of radish was recorded from NM_2 (125% STB fertilizer dose), which was statistically similar to NM_3 package. Deep tillage produced the highest pod yield of garden pea (4.54 and 1.86 t ha^{-1} for Jessore and Gazipur, respectively), which was significantly higher over MT but statistically identical to CT. The highest pod yield (5.08 and 2.30 t ha^{-1} for Jessore and Joydebpur, respectively) of garden pea was obtained with NM_2, which was followed by NM_3 and NM_1. Deep tillage produced higher yield, which was almost similar with conventional tillage when it combined with compost formulated IPNS package.

Effect of conservation tillage practices and IPNS based fertilizer management on the productivity of potato-jute- T. Aman cropping pattern

An experiment was conducted at RARS, Jessore to evaluate effect of tillage methods and IPNS (Integrated Plant Nutrition System) based fertilizer management on the productivity of the Potato-Jute-T. Aman cropping pattern. Three tillage methods viz. (i) bed planting (T_1), (ii) PTOS (Power Tiller Operated Seeder, T_2) and (iii) conventional tillage (T_3) in combination with five types of nutrient management package such as (a) STB fertilizer dose from chemical fertilizer (F_1), (b) 120% of chemical fertilizer from STB fertilizer doze (F_2), (c) 80% from chemical (Soil Test Based Fertilizer doze STB) + 20% from vermi-compost (STB) fertilizer doze (F_3), (d) 80% from chemical (STB) + 20% from convention compost (F_4) and (e) Farmers practice (F_5) were used as treatments. In case of tillage operation, bed planting gave the highest yield (24.11 t ha^{-1}) followed by 23.95 t ha^{-1} PTOS and the lowest yield (23.60 t ha^{-1}) was obtained from the conventional tillage. In case of fertilizer package, 120% STB of chemical gave the highest yield (25.18 t ha^{-1}), which was followed by F_3. The conventional compost formulated IPNS package (F_4) gave 23.53 t ha^{-1} tuber yield. The interaction effect between tillage method and fertilizer package was statistically non-significant. But T_2 (PTOS) + F_2 (120% of chemical fertilizer from STB fertilizer doze) produced the highest yield (26.33 t ha^{-1}).

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 were conducted in Grey Terrace soil of Gazipur under AEZ-28 and Terrace soil of Bogra under AEZ-26 during rabi 2014-15. There were 3 types of tillage such as minimum tillage, conventional tillage and deep tillage. 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 at both the locations. Deep tillage and IPNS based nutrient management (T_3M_3) gave the highest yield (794 kg ha^{-1}).

Chemical aspects of soil management

Long-term integrated nutrient management for sustaining soil fertility and yield of maize-mungbean- T. Aman cropping pattern

A long-term field experiment on Maize-Mungbean-T. Aman cropping pattern was conducted in the Grey Terrace Soil (AEZ 28) of Gazipur during the year of 2007-2014 with the objective of finding out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as affected by chemical fertilizers and organic manures and to make a balanced sheet of each nutrients. There were six treatments viz. T_1: Native fertility, T_2: MYG (FRG) from chemical fertilizers + 5 t ha^{-1} CD, T_3: HYG (STB) from chemical fertilizer, T_4: HYG (STB) from chemical fertilizer + 5 t ha^{-1} CD, T_5: HYG (STB) from chemical fertilizer + 3 t ha^{-1} PM and T_6: MYG (FRG) from chemical fertilizers. The experiment was laid out in RCBD design with four replications. The T_5 produced the highest yield of maize grain consistently in seven maize crops. The legume component (mungbean) produced over 1 t ha^{-1} grain and added over 13 t ha^{-1} green biomass. The third crop (T. Aman rice) also produced the highest yield in the T_5 treatment. The yields of maize and rice were statistically similar to all other fertilizer treatments. The modified treatment T_2 since 2011-12 produced statistically similar yields of maize and rice with the T_5. The native fertility treatment produced the lowest yield. This trend of influence was consistent for almost all the yield contributing characters of maize and rice. The nutrient removal by maize and rice was standard and apparently showed negative balance for some nutrients.

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 and 2014-2015 with the objective of finding 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 RCBD design with three replications. The highest grain yield of mustard 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 11.3 t ha^{-1} to 15.6 t ha^{-1}. The T. Aus and T. Aman rice yield was influenced statistically but there was no treatment effects on the grain yields. The treatment T_6, however, showed the highest yield.

Nutrient management for sustaining soil fertility and production of mustard-mungbean-T. Aman cropping pattern

A long term field trial on Mustard-Mungbean-T. Aman cropping pattern was conducted during 2000-2014 in High Ganges Floodplain Soils (AEZ-11) of Jessore. The objectives were to find out sustainable fertilizer doses for the pattern, monitor soil health, estimate uptake of different nutrient and make a balance sheet for each of the nutrient. 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 design was RCB and replicated thrice. The combined effect of 120-54-70-40-3-1 kg ha^{-1} of NPKSZnB (T_5) produced highest seed yield (1.53 t ha^{-1}) of mustard. The residual effect of 120-54-70-40-3-1 kg ha^{-1} of NPKSZnB (T_5) gave the highest yield of both grain and straw yield of mungbean and T. Aman rice. It was observed that a total amount of 2691, 570.6, 2484, 421 and 21.2 kg ha^{-1} of NPKS and Zn were removed from the soil by ten cropping cycles while 2600, 1080, 1400, 500 and 30 kg ha^{-1} of NPKS and Zn were added in the soil as nutrients. N and K removal were found to be higher than the amount added. About 114 t ha^{-1} of green biomass of mungbean from ten cropping cycles were ploughed down after grain harvest.

Integrated nutrient management for sustaining soil fertility and production of wheat-mungbean-T. Aman cropping pattern

A long term field experiment on Wheat-Mungbean-T. Aman cropping pattern was carried out in High Ganges Floodplain Soils (AEZ-11) of RARS, Jessore during 2000-2014. The objectives were to find out sustainable fertilizer recommendations, monitor soil health, estimate uptake of different nutrient for the cropping pattern & to make a balance sheet for each of the nutrient. There were six treatments viz. 125% recommended dose (RD), 100% RD, 75% RD, 50% RD, farmer's practice and native fertility. The design was RCB with three replications. Results showed consistently highest yield from each of the crops of the pattern obtained with 125% RD treatment and which were statistically similar to 100% RD treatment. As the grain yield and biomass production were higher in 125% RD treatment, the total nutrient uptake was also higher in this treatment. The nutrient balance sheet indicated a negative balance of N and S in all treatments but there were positive balances of P and Zn in all the treatments except for the native treatment. In case of K, a large amount was removed form the soil, which might lead to K depletion in the long run.

Parameterization of APSIM model for different maize varieties under different N levels and simulating their potential yield in Bangladesh

The APSIM (Agricultural Production Systems Simulator) model was introduced to simulate maize growth, development and yields in the Grey Terrace Soil of Gazipur (24.00º N latitude and 90.05º E longitude; 8.4 m elevation) (AEZ 28) using the field experimental data and climate data collected from the current experiment conducted during the rabi season of 2012-2013, 2013-2014 and 2014-2015 in the Farm of Bangladesh Agricultural Research Institute (BARI), Gazipur. There were three promising hybrid maize varieties (BHM 7, BHM 9 and Pinacale) which are generally used in the farmer's field and three nitrogen (N) levels (0. 150 and 300 kg N ha^{-1}) in the study. Experimental data from maize (*Zea mays* L.) grown under various nitrogen (N) regimes during 2013 in Gazipur were used to parameterize and evaluate the cropping systems model. APSIM was parameterized for the three varieties using N 300 kg ha^{-1} to determine the genetic coefficient, then simulated the growing periods, total above-ground biomass and yields for other N treatments. The results showed that there was a good agreement between the simulated and observed values in growing periods. The model predicted the phonological development of the crop rather well for the cultivars with 5 and 7 days difference between the observed and simulated days to maturity. The grain yield was well simulated with a 1% difference between the observed and simulated and 1 to 2% difference was obtained for total biomass for the varieties during model parameterization. Increasing N rates significantly increased grain and total biomass production irrespective of the season. These results indicated that APSIM model possessed good ability to simulate the growing periods, dynamic process of above-ground biomass and yield of maize in the Grey Terrace Soil of Gazipur (AEZ 28).

Effect of IPNS on the yield and nutrient uptake of crops on 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. There were seven treatments viz. T_1: Control, 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 + 25% OM. The experiment was laid out in RCB design with three replications. Data revealed that the T_4 treatment produced the highest yield of cauliflower which was 48.10 t ha^{-1} at Gazipur and 43.0 t ha^{-1} at OFRD, Bogra. This trend of influence was consistent for almost all the yield contributing characters of cauliflower in both the location.

Effect of IPNS for sustaining soil fertility and yield of crops on maize-mungbean-T. Aman rice cropping pattern

The experiments on Maize-Mungbean-T. Aman cropping pattern were conducted in the Grey Terrace Soil (AEZ 28) of Gazipur and Tista Meander Floodplain Soil (AEZ 3) at OFRD, Bogra during the year of 2014-15. There were seven treatments viz. T_1: Control, 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. 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 which was 8.46 t ha^{-1} at Gazipur and 10.67 t ha^{-1} at OFRD, Bogra. The highest grain yield of maize was statistically almost similar to all integrated nutrient treatments in both the location. This trend of influence of the treatment were observed with the yield contributing characters viz. plant height, cob length, cob diameter, grain per cob and 500 grain weight.

Integrated nutrient management for sustainable production and quality of onion

An experiment was conducted at Research Farm, BARI, Gazipur during rabi season of 2014-15 to investigate the effect of INM on the yield and yield components of onion. 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% STB + 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 (21.69 t ha^{-1}) of onion was obtained from T_6 treatment (100% STB chemical fertilizers + 5 t VC ha^{-1}) which was statistically similar to all integrated nutrient treatments except T_8 (75% + 3 t ha^{-1} PM) treatment. The lowest yield of onion (13.70 t ha^{-1}) was recorded from native fertility (T_1) treatment.

Effect of integrated nutrient management on the yield and quality of sweet pepper

Field experiments were carried out at the research field of soil science division, Gazipur and On farm research division, Rangpur to investigate the effect of INM 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 randomize complete block design with 3 replications. Results revealed that the T_5 (75% RD+ 3 t ha^{-1} PM Slurry) produced the highest fruit yield of 26.15 t ha^1 at Gazipur and 25.29 t ha^{-1} at Rangpur and lowest yield of 11.08 t ha^{-1} at Gazipur and 10.34 t ha^{-1} at Rangpur in control treatment (native fertility). An inclusion of 3 t PM Slurry ha^{-1} with 75% RD reduced 25% of chemical fertilizer. Integrated use of PM Slurry at the rate of 3 t ha^{-1} with 75% RD were found to be the best combinations in respect of sweet pepper yield and fertility management by enriching the soil with organic matter.

Use of vermicompost for improving cabbage yield and soil health

An experiment was conducted at BARI Research Farm, Gazipur, Regional Agricultural Research Station, Jessore and On Farm Research Division, Rangpur during the rabi season of 2014-15. 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 (74.6, 60.4 & 70.2 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.

Development of fertilizer recommendation for four crop based cropping pattern: mustard-boro–T.aus-T. Aman

The experiments on Mustard-Boro-T. Aus-T. Aman cropping pattern were conducted in Jamalpur (AEZ 8) and Jessore (AEZ 11) during the year of 2014-15 with the objective of finding 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 grain yield of mustard (BARI Sharisa 14) was significantly influenced by the fertilizer treatments. The highest grain yield of 1.86 t ha^{-1} (Jamalpur) and 1.73 t ha^{-1} (Jessore) were obtained from the T_6 treatment where 25% additional NPK was added over the 100 % STB rate.

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 with the objective of finding 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 sharply influenced by the fertilize 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.

Integrated nutrient management for sustaining soil fertility and performance of wheat-mungbean-T. Aman cropping pattern at Ishurdi

A field experiment on Wheat-Mungbean-T. Aman cropping pattern was carried out in High Ganges Floodplain Soils (AEZ-11) at RARS Ishurdi during the period of 2000-2015. There were six treatments viz. 125 % of recommended dose (RD =120-35-75-20-5 kg of N P K S Zn/ha), 100 % of RD, 75 % of RD, 50 % of RD, farmer's practice and native fertility. The experiment was laid out in randomized complete block design replicated three times. The higher yields 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 at Ishurdi

A field trial was conducted during the period of 2000-2015 in High Ganges 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 of NPKSZnB (T_2) produced the highest grain yield (1.46 t/ha) of mustard, grain yield (1.43 t ha^{-1}) of mungbean and grain yield of T. Aman (5.47 t ha^{-1}).

Effect of foliar application of zinc on wheat yield in saline areas of Satkhira

An experiment was conducted at the Agricultural Research Station (ARS), Benarpota, Satkhira during the rabi season of 2014-2015 to investigate the efficacy of foliar application of zinc on yield and yield components of wheat. There were seven treatment combinations viz. T_1 = 100% recommended dose (RD) of Zn applied in the form of conventional method, T_2 = 100% RD of Zn (10 kg zinc sulfate ha^{-1}) in the form of foliar application, T_3 = 75% RD of Zn in the form of foliar application, T_4 = 50% RD of Zn in the form of foliar application, T_5 = 75% RD of Zn as foliar and 25% as conventional, T_6 = 75% RD of Zn as conventional and 25% as foliar, T_7 = 50% RD of Zn as conventional and 50% as foliar. The trial was fertilized with urea (200 kg ha^{-1}), TSP (160 kg ha^{-1}), MoP (45 kg ha^{-1}) and Cowdung (10 t ha^{-1}). The highest grain yield (4.75 t ha^{-1}) was recorded in T_3 treatment. Highest MBCR of 3.12 was obtained from T_3 treatment. The lowest level of soil salinity (4.32 dS m^{-1}) was recorded at the sowing time and the highest level of salinity (12.33 dS m^{-1}) was recorded at the harvesting stage.

Effect of different planting methods on soil salinity and yield of tomato in saline areas of Satkhira

An experiment was conducted at Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2014-15 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 (>6 dS m^{-1}) + Conventional planting method, T_2 = Saline water (>6 dS m^{-1}) + Flat bed planting method, T_3 = Saline water (>6 dS m^{-1}) + furrow-bed planting method and T_4= Saline water (>6 dS m^{-1}) + Slope bed planting method. The highest fruit yield (76.29 t ha^{-1}) was recorded in T_4 treatment. The lowest fruit yield (68.83 t ha^{-1}) was recorded in T_1 treatment. The highest gross retrurn (Tk. 381450 ha^{-1}) and highest MBCR (6.01) was obtained from T_4 treatment. The lowest level of soil salinity (2.46 dS m^{-1}) was recorded at planting stage and the highest level of salinity (12.14 dS m^{-1}) was recorded in T_3 treatment at last harvesting stage. Lowest level of soil salinity compared to other treatments was recorded in T_4 treatment.

Micronutrient aspects of Soil Management

Effect of foliar application 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 Bangladesh Agricultural Research Institute (BARI), Gazipur (AEZ-28). The experiment was designed in RCBD with 12 treatments. The micronutrient molybdenum (Mo) in the form of ammonium molybdate $(NH4)_6Mo_7O_{24}{\cdot}2H_2O$ containing 54% of Mo was applied as foliar spray at three different stages of plant growth: i) 20 days after transplanting, ii) 30 days after transplanting and iii) 45 days after transplanting. The treatment combinations of foliar spray of Mo were –T_1: Mo - Control; T_2: M_1 (0.025 %), T_3: M_2 (0.05 %) and T_4: M_3 (0.1 %). The growth and yield of cauliflower were significantly influenced by foliar spray of molybdenum. All parameters of cauliflower showed higher tendency in T_3 treatments. The highest curd weight (1.24 kg) and curd yield (51.0 t ha^{-1}) was observed in T_3 treatment (0.05% foliar spray of molybdenum). The lowest curd weight (0.92 kg) and curd yield (42.2 t ha^{-1}) was observed in T_1 treatment (no spray of molybdenum-control). Thus, foliar application of Mo on cauliflower seemed to be more effective for improving yield of cauliflower in the study area of Gazipur (AEZ-28).

Zinc-iron relationship in wheat plant grown under drought 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, Gazipur, during November 2014 to March 2015. 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 interaction effect of irrigation and foliar application of zinc and iron significantly influenced the yield and yield components of wheat. The highest yield (4.45 t ha^{-1}) was recorded in stopping irrigation at grain filling stage with combined application of zinc and iron which is identical with regular irrigation with 0.05% foliar application of zinc and combined application of zinc and iron. Water stress at crown root initiation stage had the most negative effect on growth and yield. Foliar application of zinc 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 fairly improved the effects caused by drought stress.

Arsenic contamination in soil, water and vegetables in Bangladesh: health risk assessment

An investigation was carried out during 2014 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 highly arsenic affected Faridpur and moderately affected Gazipur districts. Results revealed that the arsenic-contaminated irrigation water (0.318-0.643 mg/L) and soil (4.6-9.6 mg kg^{-1}) considerably influenced in the accumulation of arsenic in vegetables in the study area. Arsenic concentrations of irrigation water samples were many folds higher than the WHO recommended permissible limit for drinking water (0.01 mg/L) and FAO permissible limit for irrigation water (0.10 mg/L). But, the levels of arsenic in soil were lower than the reported global average of 10.0 mg kg^{-1} and was much below the EU recommended maximum acceptable limit for agricultural soil (20.0 mg kg^{-1}). The total arsenic concentrations in the studied samples ranged from 0.14 to 0.61 and 0.1 to 0.597 mg kg^{-1} in Faridpur and Gazipur respectively. The highest and lowest mean arsenic concentrations (mg kg^{-1}) were found in red amaranth (0.61) and cauliflower (0.14) in Faridpur respectively and that of in Gazipur were turnip (0.597) and sweet gourd (0.10) respectively. Mean arsenic concentrations (mg kg^{-1}) were observed in cabbage (0.38), radish (0.38), carrot (0.53), spinach (0.36) and lower arsenic concentration (mg kg^{-1}) were in green chilli (0.20), brinjal (0.24), country bean (0.23), bottle gourd (0.24), yard long bean (0.17), bitter gourd (0.23), sweet gourd (0.29) etc. in Faridpur. Whereas, in Gazipur the content (mg kg^{-1}) of arsenic were higher in radish (0.31), green banana (0.35), bitter gourd (0.30), papaya (0.33) and lower in cauliflower (0.19), cabbage (0.18), brinjal (0.20), tomato (0.26), country bean (0.27), red amaranth (0.22), coriander leaf (0.22), carrot (0.21), white goosefoot (0.24) and spinach (0.23) etc. Arsenic concentrations in the studied crop samples were found not to exceed the food hygiene concentration limit (1.0 mg kg^{-1}). Thus, the present study reveals that vegetables grown in the study area are safe for consumption, and the arsenic accumulation in the crops should be monitored periodically.

Screening of zinc rich wheat genotype

To explore the effect of genotype and genotype X environment interaction on zinc concentration in wheat grains, twenty two wheat varieties of three contrasting environments (Rajshahi, Jessore and Gazipur) were evaluated for grain concentrations of zinc. The experiments were laid out in RCB design replicated thrice. Zinc showed variation ranging from 17.5 mg kg^{-1} to 32.9 mg kg^{-1}. Prodip (16) contained high amount of zinc as well as showed moderate stability across the locations. The Kheri (1), Kolyansona (2) were promising varieties for highest zinc concentration in the grain.

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 to estimate the requirement of zinc and boron on the yield of Potato-Maize-T. Aman in the pattern and also 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. Application of zinc and boron in the successive crop was found prominent for yield increment in comparison to controls. 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.

Effectiveness of soil and foliar applications of zinc and boron on the yield of tomato

A field experiment was carried out to study the effectiveness of soil and foliar application of micronutrients on the yield of tomato (*Lycopersicon esculentum* Mill.) at Bangladesh Agricultural Research Institute (BARI), Gazipur, located at 23º59′26″ N and 90º24′52″ E. The micronutrients zinc (Zn) in the form of zinc sulphate ($ZnSO_4.7H_2O$) as zinc source at the rate of 0.05 % 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 tomato 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 (81.3 t ha^{-1}) while the control without Zn (0.0) and B (0.0) produced 63.6 t 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 18.9 to 27.8% and 6.03 to 14.0% respectively, over control and soil application. The integrated use of foliar application of micronutrients and soil application of macronutrients recommended to enhanced tomato yield. Foliar application of micronutrients, particularly of Zn and B found effective technology for increasing the yield of tomato in alkaline soils.

Mercury accumulation and partitioning in selected spices grown in soil contaminated with waste water irrigation

The mercury (Hg) uptake, distribution and subsequent metal partitioning in three spices plants namely chili (*Capsicum annuum*), onion **(***Allium cepa***)** and coriander (*Coriandrum sativum*) and the rizosphere soils of the respective crops were investigated. Mercury was analyzed with Atomic Absorption Spectrophotometer using Vapor and Hydride Generation assembly. The accumulation of Hg in the plants was twofold higher in roots, stem and leaves at waste water-irrigated site compared to concentrations were recorded at clean water-irrigated site. Mercury concentrations for soils and plants exhibited the hierarchy of soil > roots > leaves > stems. The concentrations of Hg in plants was chili > coriander > onion. Plants sampled from the waste water-irrigated site was found to have moderate to high concentrations of Hg (9.05–27.5 µg kg^{-1}) in both the roots and aerial parts, thus reflecting the variability of this element content among the plant species. The distribution of Hg content in plants was positively correlated with that in soils. The Hg in the soil, 54 to 75% was transferred to the root, and 50 to 58% was transferred to the aboveground plant organs. However, concentration of Hg found in the samples of all three types of spices, not exceeding the permissible limits provided by FAO/WHO. Pollution Index values not exceeded 1.0 but very close (0.92), therefore, soil was 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

The 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* L.) in metal contaminated soil (10 kg/pot) 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 19.7 to 27.3% for fern dust, 21.3 to 40.3 % for water hyacinth, 14.2 to 22.1% for mustard stover dust, 9.09 to 14.6% 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 21.7 to 27.3 % for cow manure, 25.2 to 70.1 % for poultry manure and 29.5 to 77.9 % 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.

Effects of phosphorus in reducing arsenic availability in soils and arsenic uptake by maize and rice

A pot experiment was carried out in the micronutrient experimental field of Soil Science Division of the Bangladesh Agricultural Research Institute (BARI), Gazipur during 2015 with a view of 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 $As_{30}P_{60}$. 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. As was positively and significantly correlated with P in shoot (r = 0.9375; P<0.01) and root (r = 0.9512, P<0.01) in rice plant. In maize, the relation was poor than that of rice plant (shoot r = 0.8939, P<0.01; and root r = 0.8927, P<0.01). The plants took up much greater amounts of P than As. In –P plants for the highest As concentration in As_{30} treatment was found to be 67% in root and 33% in shoot; whereas in +P plants, at the same As concentration, 77% was in the root and 23% in shoot for rice plant. For the maize, it was 89% and 88% in root and 11% and 12% in shoot, respectively both in –P and +P plants. The results presented here indicated P supply effect in higher As allocation to the plant parts. The present findings suggest that phosphate application might serve as a feasible strategy for more efficient phytoremediation of arsenic contaminated soils.

Effect of molybdenum on yield and yield components of different pulse crop

A field experiment was carried out at the Regional Agricultural Research Station, Ishwardi, Pabna (AEZ-11) during rabi season of 2014-2015 to evaluate the response of molybdenum on different pulse crops viz. lentil, chickpea, grasspea and fieldpea with a blanket done $N_{20}P_{20}K_{35}S_{20}Zn_2B_2$ kg/ha of chemical fertilizers. The experiment was designed in a RCBD having three replications and four levels of molybdenum (0, 0.5, 1 and 1.5 kg ha^{-1} Mo) in each pulse crops. The highest seed yield were obtained in $M_{1.0}$ kg ha^{-1} in all four pulse crops i.e. 1.90 t ha^{-1} in lentil; 1.81 t ha^{-1} in fieldpea; 1.65 t ha^{-1} in grasspea and 1.82 t ha^{-1} in chickpea. Molybdenum at the rate of 1 kg ha^{-1} with the said blanket dose could be regarded as the optimum dose for the yield maximization of the above pulse crops in the study area of Ishwardi (AEZ-11).

Response of blackgram to boron in high ganges river floodplain soils

A field experiment was conducted in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishwardi, Pabna during kharif-II season of 2014-2015 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 and the experiment was designed in Randomized Complete Block Design having three replication. Among the treatments B_5 (2 kg ha^{-1}) gave the highest seed yield (1.44t ha^{-1}). However, from regression analysis, the optimum dose of boron was found to be 1.9 kg ha^{-1} for yield maximization of blackgram in the study area of High Ganges River Floodplain Soils of Bangladesh (AEZ-11).

Response of groundnut to boron in high ganges river floodplain soils

Field trial on groundnut (BARI Groundnut-8) was conducted in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishwardi during rabi season of 2014-2015 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. Among the treatments, B_2 kg 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).

Microbiological Aspects of Soil Management

Study on *Rhizobium*, *Azotobacter* and phosphate solubilizing bacterial (PSB) population status in soils of different AEZS of Bangladesh

***Rhizobium* population status:** Thirteen soil samples were collected from selected locations of different AEZs of Bangladesh to know the *Rhizobium* population at different AEZs (6 AEZs) of Bangladesh. Soil samples were collected from RARS, Jessore (AEZ-11); RARS, Ishurdi (AEZ-11); Farmer’s field, Pabna (AEZ-11); RARS, Rahmatpur (Fruit plants) (AEZ-13); RARS, Rahmatpur (AEZ-13); BARI Central Farm (AEZ-28); RARS, Jessore (Fruit plants) (AEZ-11); RARS, Ishurdi (Agronomy expt.) (AEZ-11); BARI Central Farm, Joydebpur (LBR potato) (AEZ-28); ARS, Comilla (AEZ-29); RARS, Jessore (LBR potato), RARS, Burirhat, Rangpur (AEZ-03); ARS, Bogra (LBR potato) (AEZ-03); RARS, Hathazari (LBR potato) (AEZ-23). *Rhizobium* was grown in media and *Rhizobium* colonies were counted. The highest *Rhizobium* population (5.0 x 10^5 g^{-1} soil) was found in soils of RARS, Jessore (Chickpea expt.) (AEZ-11) and RARS, Rahmatpur (Groundnut expt.) (AEZ-13), and the lowest population (1.0 x 10^3 g^{-1} soil) was observed in soils of RARS, Jessore (Fruit plants) (AEZ-11).

***Azotobacter* population status:** Eighteen soil samples were collected to know the *Azotobacter* population in different AEZs of Bangladesh (covering 6 AEZs) viz. RARS, Jessore (AEZ-11); RARS, Ishurdi (AEZ-11); Farmer’s field, Pabna (AEZ-11); RARS, Rahmatpur (Fruit plants) (AEZ-13); RARS, Rahmatpur (AEZ-13); BARI Central Farm (AEZ-28); RARS, Jessore (Fruit plants) (AEZ-11); RARS, Ishurdi (Agronomy expt.) (AEZ-11); BARI Central Farm, Joydebpur (LBR potato expt.) (AEZ-28); ARS, Comilla (LBR potato expt.) (AEZ-29); RARS, Jessore (LBR potato expt.), RARS, Burirhat, Rangpur (AEZ-03); ARS, Bogra (LBR potato expt.) (AEZ-03); RARS, Hathazari (LBR potato expt.) (AEZ-23). *Azotobacter* was grown in media and *Azotobacter* colonies were counted. The highest *Azotobacter* population (8.5 x 10^5 g^{-1} soil) was found in soils of BARI Central Farm, Joydebpur (groundnut vermicompost expt.) (AEZ-28) and the lowest population (2.5 x 10^4 g^{-1} soil) was observed in ARS, Bogra (AEZ-03).

Phosphate solubilizing bacteria (psb) population status: Eighteen soil samples were collected to know the phosphate solubilizing bacteria (PSB) population status in soils of different AEZs of Bangladesh. Soil samples were collected from RARS, Jessore (AEZ-11); RARS, Ishurdi (AEZ-11); Farmer’s field, Pabna (AEZ-11); RARS, Rahmatpur (Fruit plants) (AEZ-13); RARS, Rahmatpur (AEZ-13); BARI Central Farm (AEZ-28); RARS, Jessore (Fruit plants) (AEZ-11); RARS, Ishurdi (Agronomy expt.) (AEZ-11); BARI Central Farm, Joydebpur (LBR potato expt.) (AEZ-28); ARS, Comilla (LBR potato expt.) (AEZ-29); RARS, Jessore (LBR potato expt.), RARS, Burirhat, Rangpur (LBR potato expt.) (AEZ-03); ARS, Bogra (LBR potato expt.) (AEZ-03); RARS, Hathazari (LBR potato expt.) (AEZ-23). Phosphate solubilizing bacteria was grown in Pikovskaya's media and PSB colonies were counted. The highest PSB population (5.0×10^5 g^{-1} soil) was found in soils of BARI Central Farm (brinjal expt.) and groundnut vermicompost expt. (AEZ-28), and the lowest population (1.0×10^4 g^{-1} soil) was observed in the soils of BARI Central Farm (chickpea expt.).

Assessment of Arbuscular Mycorrhizal (AM) association in some fruit and spices plants

Rhizosphere soils of some fruit and spices plants from Regional Agricultural Research Station, Jessore; Regional Agricultural Research Station, Rahmatpur, Barisal and Agricultural Research Station, Burirhat, Rangpur were collected during 2013-2014 and 2014-2015 for counting AM spore population and determining colonization (%) in their roots. During 2014-2015, at Jessore, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 62.3 (Bohera) to a maximum of 161.0 (Kodbael). At Rahmatpur, Barisal, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 61.3 (Kathal) to a maximum of 209.0 (Amra) in 2014-2015. At Burirhat, Rangpur, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 61.7 (Supari) to a maximum of 220.7 (Kamranga). 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 Jessore, among all the fruit and spices plants, the highest root colonization (35.0%) was found in Amlaki, the close colonization (30%) was observed in Aam, Batabilebu, Hartaki, Jalpai, Kamranga, Kodbael and Supari, and the lowest colonization (10.0%) was found in Atafal, Chalta, Khejur, Kola, Kul/Boroy and Malta. At Rahmatpur, among all the fruit and spices plants, the highest colonization (40.0%) was found in Amra, Gab and Jam, and the lowest colonization (10.0%) was found in Bilatigab, Dewa, Kathal, Kul/Boroy, Lebu, Litchu, Narikel, Tejpata and Tetul. At Rangpur, among all the fruit and spices plants, the highest colonization (30.0%) was found in Jam and Kamranga; and the lowest colonization (10.0%) was found in Bael, Jamrul, Lebu, Malta, Naspati, Narikel, Pepey, Sajna and Taikor.

Effect of late blight resistant gene on soil microbes under confined field trials of potato varieties

Confined field trials of Late Blight Resistant (LBR) potato varieties was conducted at six different locations of Bangladesh to test the suitability of LBR potato crops in the country. Six varieties viz. D-951(2), D-951(12), D-951(13), D-951(137), D-951(304), D-951(3) along with one control (Diamant) were cultivated in six different parts of the country viz. Bangladesh Agricultural Research Institute Central Farm, Gazipur; 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 Randomized Complete Block Design with three replications. 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. Late Blight Resistant of potato varieties showed no detrimental effects on soil microbial population.

Effect of Biofertilizer, Vermicompost and chemical fertilizers on groundnut

A field experiment was conducted at BARI Central Farm, Gazipur, Gazipur to evaluate the effect of *Rhizobium* biofertilizer, vermicompost and chemical fertilizers on groundnut during the rabi season of 2013-2014 and 2014-2015. The crop variety was BARI Chinabadam-8 and *Bradyrhizobium* strain was BARI RAh-892. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Bradyrhizobium* + IPNS based PKSZnB, T_7: VC @ 5 t ha^{-1} + *Bradyrhizobium* + IPNS based PKSZnB, T_8: 100% NPKSZnB, T_9: *Bradyrhizobium* + 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. *Bradyrhizobium* inoculated groundnut with vermicompost @ 5 t ha^{-1} and IPNS based PKSZnB increased nodule number (95.2 plant^{-1} in 2014 and 97.2 plant^{-1} in 2015), nodule weight (145.8 mg plant^{-1} in 2014 156.5 mg plant^{-1} in 2015) and root weight (0.47 g plant^{-1} in 2014 and 0.46 g plant^{-1} in 2015) and shoot weight (13.17 g plant^{-1} in 2014 and 12.56 g plant^{-1} in 2015). It was observed that the same treatment produced the highest nut yield (3.28 t ha^{-1}, 60.8% higher over control in 2014 and 2.91 t ha^{-1}, 47.0% higher over control in 2015) of groundnut which was identical with full doses of chemical fertilizers (T_8 treatment) and *Bradyrhizobium* inoculum plus full doses of chemical fertilizers except urea nitrogen (T_9 treatment) in 2014, and with VC @ 2.5 t ha^{-1} plus *Bradyrhizobium* plus IPNS based PKSZnB (T_6 treatment), full doses of chemical fertilizers (T_8 treatment) and *Bradyrhizobium* inoculum plus full doses of chemical fertilizers except urea nitrogen (T_9 treatment) in 2015. This indicated that application of vermicompost @ 5.0 t ha^{-1} plus *Bradyrhizobium* inoculant reduced a considerable amount of chemical fertlilizers. Vermicompost exhibited better performance in groundnut. Benefit cost ratio (BCR) revealed that the highest BCR (5.78 in 2014 and 4.79 in 2015) was found in T_9 treatment followed by T_8, T_7 and T_6 treatment in 2014, and T_8, T_6 and T_4 treatment in 2015. As the yield was higher in T_7 treatment, rich farmer can adopt this treatment but poor farmer can adopt T_9 treatment (*Bradyrhizobium* inoculant + 100%PKSZnB). From the trial, it could be concluded that vermicompost @ 5 t ha^{-1} plus *Bradyrhizobium* inoculant along with IPNS based chemical fertilizers except N might be recommended for groundnut cultivation in Grey Terrace Soil (AEZ-28). From economic point of view, *Bradyrhizobium* inoculant along with IPNS based chemical fertilizers except N was the best treatment.

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 *Glomus* spp. alone or in combination with rhizobial inoculum in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur in 2014-2015. The experiment was designed in CRD 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±5.5 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 *Glomus spp* 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, Bangladesh Agricultural Research Institute, Gazipur in 2014. Mycorrhizal plants showed better performance in terms of germination (%), vigour, yield and yield contributing characters, spore population/100 g soil and root colonization (%) than non-mycorrhizal plants. With increasing arsenic concentration, germination (%), vigour, yield and yield contributing characters, mycorrhizal spore population and root colonization in the rhizosphere soil, decreased significantly ($p<0.01$). The mycorrhizal plants showed 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. 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.

Fect of Arbuscular Mycorrhizal fungi on tolerance to lentil (*Lens culinaris*) at different salinity 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. 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, Gazipur from December, 2014 to March, 2015. 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 ($p<0.01$). 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.

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 *Glomus* spp. alone or in combination with *Trichoderma harzianum* in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur in 2014. The result indicated that AMF alone were less effective than *Trichoderma harzianum* in improving growth and disease management but effective in germination (%). 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 *Glomus* spp. 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.

Biocontrol of foot and root rot disease of soybean (*Glysine max*) by dual inoculation with *Bradyrhizobium* 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 soybean 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 *Glomus* spp. alone or in combination with rhizobial inoculum in the nethouse of Soil Science Division, Bangladesh Agricultural Research

Institute, Gazipur in 2014-2015. The experiment was designed in RCBD with eight treatments and four replications. Soybean variety Shohag (PB-1) was used as a test crop. Peat based rhizobial inoculum (BARI RGm-901) was used in this experiment. Soil based AM inoculum containing about approxmate 168 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 rolfsi*+*Rhizobium*, *Sclerotium rolfsii*+AM+*Rhizobium* and Control. Dual inoculation significantly increased germination (%), growth parameters and yield contributing characters of soybean compared to single inoculation or any other treatments. The combination of *Glomus* spp. 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.

Response of chickpea varieties to elite strains of *Rhizobium*

Field experiments were conducted at Bangladesh Agricultural Research Institute, Gazipur; Regional Agricultural Research Station, BARI, Ishurdi and Regional Agricultural Research Station, BARI, Jessore during 2014-2015 to study the response of inoculation with different varieties and 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, 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. 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 Gazipur but at Jessore, BARI Chola-9 produced highest nodule number. Nodule weight recorded in BARI Chola-9 was higher at two locations except at Gazipur. The highest seed yield (1.52 t ha^{-1} at Ishurdi, 1.61 t ha^{-1} at Jessore and 1.52 t ha^{-1} at Gazipur) was observed in BCX-05008-11, BARI Chola-9 and BCX-05008-11 respectively. The highest stover yield (2.81 t ha^{-1}, 3.23 t ha^{-1} and 2.66 t ha^{-1} at Ishurdi, Jessore and Gazipur, respectively) was observed in BARI Chola-9. The interaction effect revealed that the highest seed yield of 1.68 t ha^{-1} at Ishurdi and 1.73 t ha^{-1} at Gazipur were recorded by inoculated BCX-05008-11 but at Jessore, the highest seed yield (1.75 t ha^{-1}) was recorded by inoculated BARI Chola-9.

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 2014-2015. 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. Biomass yield, seedling height was found significantly higher with combined application of cowdung, arbuscular mycorrhiza (AM) and phosphorus compared to the remaining treatments.

Response of groundnut varieties to elite strains of *Bradyrhizobium*

A Field experiment was conducted at Bangladesh Agricultural Research Institute, Gazipur during 2014-2015 to study the response of inoculation with different varieties, 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 with 3 replications. Each variety was tested with/without *Bradyrhizobium* inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, root weight, shoot weight, plant height (cm), nut plant^{-1}, kernel nut^{-1},100- kernel weight (g), shelling percentage (%), 100-nut weight, nut yield (t ha^{-1}) and stover yield (t ha^{-1}) compared to non-inoculated plants. Among 4 varieties/advance lines, BARI Chinabadam-8 produced the highest nodule number. Nodule weight, root weight and shoot weight was found the highest in BARI Chinabadam-9. Plant height and nut plant^{-1} was found the highest in ICGV-96346 advance line. Kernel nut^{-1}, 100-kernel weight (g) and kernel weight of 100-nut was found the highest in BARI Chinabadam-8. Shelling percentage (%) was found the highest in BINA Chinabadam-5 which was followed by ICGV-96346. Stover yield and nut yield (t ha^{-1}) was found significantly the highest in BARI Chinabadam-9 but 100-nut weight (g) was found significantly the highest in BARI Chinabadam-8.

Effect of Arbuscular Mycorrhizal fungi and phosphorus on onion at Bogra

A field experiment was conducted at Spices Research Centre, Shibgonj, Bogra during rabi season of 2013-2014 and 2014-2015 to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on 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 m^{-2} in seedbed for producing onion seedlings. The treatment combinations were: T_1P_1U: 0% P x Without AM, T_2P_2U: 50% P x Without AM, T_3P_3U: 100% P x Without AM, T_4P_1AM: 0% P x With AM, T_5P_2AM: 50% P x With AM, T_6P_3AM: 100% P x With AM. Mycorrhizal inoculation significantly increased yield and yield attributes of onion in both of the years. Plant height (cm) was non-significant during 2013-2014 but significant during 2014-2015. The plant which received AM in nursery bed produced higher bulb yield than without AM in all phosphorus levels for onion. The highest onion yield (11.3 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 9.71% higher over 100% P without AM and 4.63% higher over 100% P with AM in the year of 2013-2014. The highest onion yield (11.1 t ha^{-1}) was recorded in 50% P with AM which was 2.78% higher over 100% P without AM and 0.91% higher over 100% P with AM in the year of 2014-2015. The result indicated 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 studies in P deficient soil and economic analysis is required for final recommendation.

Effect of Arbuscular Mycorrhizal fungi and phosphorus on onion at Rahmatpur

A field experiment was conducted at Regional Agricultural Research Station, Rahmatpur during rabi season of 2013-2014 and 2014-2015 to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on 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 m^{-2} in seedbed for producing onion seedlings. The treatment combinations were: T_1P_1U: 0% P x Without AM, T_2P_2U: 50% P x Without AM, T_3P_3U: 100% P x Without AM, T_4P_1AM: 0% P x With AM, T_5P_2AM: 50% P x With AM, T_6P_3AM: 100% P x With AM. Mycorrhizal inoculation significantly increased bulb length (cm), bulb diameter (cm), bulb weight (g) and yield (t ha^{-1}) in both of the years. Plant height (cm) was non-significant in both of the years but number of leaves plant^{-1} was non-significant during 2013-2014 and significant during 2014-2015. The plant which received AM in nursery bed produced higher bulb yield than without AM in all phosphorus levels for onion. The highest onion yield (12.0 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 4.35% higher over 100% P without AM and 1.69% higher over 100% P with AM in the year of 2013-2014. The highest onion yield (12.2 t ha^{-1}) was recorded in

50% P with AM which was 1.67% higher over 100% P without AM and 0.83% higher over 100% P with AM in the year of 2014-2015. The result indicated 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 at Ishurdi

A field experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during rabi season of 2013-2014 and 2014-2015 to study the effect of combined use of arbuscular mycorrhiza and phosphorus on tomato and to reduce the 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-14 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 m^{-2} in seedbed for producing tomato seedlings. The treatment combinations were: T_1P_1U: 0% P x Without AM, T_2P_2U: 50% P x Without AM, T_3P_3U: 100% P x Without AM, T_4P_1AM: 0% P x With AM, T_5P_2AM: 50% P x With AM, T_6P_3AM: 100% P x With AM. Mycorrhizal inoculation significantly increased number of cluster $plant^{-1}$, fruit length (cm), fruit diameter (cm) and fruit yield (t ha^{-1}) both in the years of 2013-2014 and 2014-2015 but root length (cm) and plant height (cm) was non-significant in both of the years. Collar diameter (mm) is non-significant in the year of 2013-2014 but significant in the year of 2014-2015. The plant which received AM in nursery bed produced higher yield than without AM in all phosphorus levels. The highest tomato yield (53.1 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 1.92% higher over 100% P without AM and 1.14% higher over 100% P with AM in the year of 2013-2014. The highest tomato yield (78.0 t ha^{-1}) was recorded in 50% P with AM which was 3.72% higher over 100% P without AM and 1.30% higher over 100% P with AM in the year of 2014-2015. The result indicated 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 at Jamalpur

A field experiment was conducted at Regional Agricultural Research Station, Jamalpur during rabi season of 2013-2014 and 2014-2015 to study the effect of combined use of arbuscular mycorrhiza and phosphorus on tomato and to reduce the 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-14 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 m^{-2} in seedbed for producing tomato seedlings. The treatment combinations were: T_1P_1U: 0% P x Without AM, T_2P_2U: 50% P x Without AM, T_3P_3U: 100% P x Without AM, T_4P_1AM: 0% P x With AM, T_5P_2AM: 50% P x With AM, T_6P_3AM: 100% P x With AM. Mycorrhizal inoculation significantly increased number of fruit $plant^{-1}$, fruit lengtht (cm), fruit diameter (cm), fruit weight (g $fruit^{-1}$) and fruit yield (t ha^{-1}) both in the years of 2013-2014 and 2014-2015 but plant height (cm) was non-significant in the year of 2013-2014. The plant which received AM in nursery bed produced higher yield than without AM in all phosphorus levels. The highest tomato yield (42.8 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 33.3% higher over 100% P without AM and 5.68% higher over 100% P with AM in the year of 2013-2014. Arbuscular mycorhiza also suppressed late blight of tomato disease during this year. The highest tomato yield (91.7 t ha^{-1}) was recorded in 50% P with AM which was 11.2% higher over 100% P without AM and 5.04% higher over 100% P with AM in the year of 2014-2015. The result indicated 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 at Rahmatpur

A field experiment was conducted at Regional Agricultural Research Station, Rahmatpur during rabi season of 2013-2014 and 2014-2015 to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on tomato and to reduce the 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-14 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 m^{-2} in seedbed for producing tomato seedlings. The treatment combinations were: T_1P_1U: 0% P x Without AM, T_2P_2U: 50% P x Without AM, T_3P_3U: 100% P x Without AM, T_4P_1AM: 0% P x With AM, T_5P_2AM: 50% P x With AM, T_6P_3AM: 100% P x With AM. Mycorrhizal inoculation significantly increased number of cluster plant^{-1}, number of fruit plant^{-1}, fruit lengtht (cm), fruit diameter (cm) and fruit yield (t ha^{-1}) both in the years of 2013-2014 and 2014-2015 but plant height (cm) was non-significant in both of the years. The plant which received AM in nursery bed produced higher yield than without AM in all phosphorus levels. The highest tomato yield (51.3 t ha^{-1}) was recorded in 50% P with AM (AM was used in nursery bed) which was 4.06% higher over 100% P without AM and 0.00% higher over 100% P with AM in the year of 2013-2014. The highest tomato yield (64.4 t ha^{-1}) was recorded in 50% P with AM which was 2.55% higher over 100% P without AM and 1.90% higher over 100% P with AM in the year of 2014-2015. The result indicated that inoculation of AM used in nursery bed can save 50% P in the field if effective mycorrhizal biofertilizer can be used. 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.

10 AGRONOMY

Crop Management

Effect of harvesting stage for quality vegetable production of different varieties of bushbean

The experiment was conducted at the Agronomy research field of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during rabi seasons of 2014-2015 to maximize quality vegetable production of bush bean from different harvesting stage. The treatments comprised seven harvesting stage viz. 9, 10 11, 12, 13, 14 and 15 days after flowering (DAF) and three varieties like BARI Jharsheem 1, BARI Jharsheem 2 and BARI Jharsheem 3 were used. The experiment was laid out in a randomized complete block design with three replications. The crop was fertilized with 120-40-60 -12-3 N-P-K-S-Zn kgha^{-1}, 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 35 days after sowing (DAS). Pods plant^{-1}, pod length, individual pod weight and pod yield of bush bean varied significantly due to variety and harvesting time. The highest number of pods plant^{-1} (15.29) was recorded in BARI Jharsheem 2 when harvested at 14 days after flowering (DAF) which was statistically similar to same variety and harvested at 13 and 15 DAF. The lowest no. of pods plant^{-1} was recorded in all the varieties harvested at 9 DAF. The maximum pod length (13.37 cm) was obtained from BARI Jharsheem 3 when harvested at 15 DAF, which was identical with BARI Jharsheem 1 harvested at 14 DAF. The shortest pod (8.37 cm) was recorded in BARI Jharsheem 2 harvested at 9 DAF. The highest individual pod yield (5.80g) was recorded in BARI Jharsheem 3 harvested at 15 DAF which was followed by BARI Jharsheem 1 harvested at 15 DAF (5.74g). The lowest individual pod yield was recorded in BARI Jharsheem 2 harvested at 9 DAF (1.35g). The highest pod yield (22.15 t ha^{-1}) was recorded in BARI Jharsheem 2 when harvested at 15 DAF followed by BARI Jharsheem 1 (21.99 t ha^{-1}) harvested at 15 DAF. The lowest pod yield was recorded in BARI Jharsheem 3 harvested at 9 DAF (9.85 t ha^{-1}). Organoleptic test indicated that the quality (softness and taste) of bush bean varieties remarkably influenced by harvesting time. Results showed that pods harvested earlier (9 DAF) gave lower yield and ascorbic acid and β- carotene content but when pods harvested at 10-12 days after flowering gave reasonable good yield and nutrient content also for quality vegetable production of BARI Jharsheem 1 and BARI Jharsheem 2.

Effect of planting technique on tuber yield of potato

The experiment was conducted at the Agronomy research field of BARI during *rabi* season of 2013-14 and 2014-15 to find out appropriate planting technique of potato for higher potato production. Three planting techniques viz. single eye planting (30 cm × 10 cm), single eye double row *zig zag* planting (10 cm/30 cm × 10 cm) and half cut tuber planting technique (30 cm × 25 cm) were compared with recommended planting technique (60 cm × 25 cm). The trial was laid out in RCB design with three replications. The variety was BARI Alu 8 (Cardinal). The potato was planted on 25 and 20 November 2013 and 2014, respectively. Chemical fertilizers were applied at the rate of 180-40-180-20-4-1.2 kg/ha of NPKSZn and B, respectively (FRG, 2012). Half of NK and full dose of other fertilizers were applied as basal. Rest of NK was top dressed at 30 days after planting (DAP) followed by irrigation.

Another irrigation was provided at 60 DAP. One weeding was done at 45 DAP. Fungicide (Ridomil gold) was sprayed 10-day intervals from 35 to 75 DAP to prevent late blight disease in both years. The crop was harvested on 25 and 20 February 2014 and 2015, respectively (92 DAP). The highest marketable tuber yield (27.10 t/ha in 2013-14 and 26.75 t/ha in 2014-15) and gross return (TK 271000/ha in 2013-14 and TK 267500 /ha in 2014-15) were obtained from single eye double row *zig zag* planting (10 cm/30 cm × 10cm). But the highest gross margin (TK 124434/ha in 2013-14 and TK 121434/ha in 2014-15) and BCR (1.97 and 1.94 in 2013-14 and 2014-15, respectively) was obtained from half cut tuber (30 cm × 25 cm) planting technique. Based on two years study, it might be concluded that both single eye planting technique with 30 cm × 10 cm and 10 cm/30 cm × 10cm spacing would be better for getting higher tuber yield but half cut tuber (30 cm × 25 cm) planting technique would be better for getting higher economic return than recommended planting technique.

Effect of integrated nutrient management of inorganic and organic fertilizers on the performance of wheat

The experiment was conducted at Regional Agricultural Research Station, Rahmatpur, Barisal during rabi season 2014-15 to study the effect of bio-slurry on wheat production. The experiment was laid out in a randomized complete block design with 3 replications and spacing of 20 cm apart rows continuous seeding. Nine treatments viz. 100% RF+Bio-slurry 0 t ha^{-1}, 100% RF+Bio-slurry 5 t ha^{-1}, 100% RF+Bio-slurry 10 t ha^{-1}, 50% RF+Bio-slurry 0 t ha^{-1}, 50% RF+Bio-slurry 5 t ha^{-1}, 50% RF+Bio-slurry 10 t ha^{-1}, 75% RF+Bio-slurry 0 t ha^{-1}, 75% RF+Bio-slurry 5 t ha^{-1} , 75% RF+Bio-slurry 10 t ha^{-1}. One third of urea and full amount of all fertilizers were applied as basal dose and the rest urea was applied at 25 DAS and 50 DAS. The seeds (BARI Gom 26) were sown on 19 November, 2014. The crop was harvested on 28 March, 2015. Yield and yield contributing characters of wheat significantly affected by inorganic fertilizers and bio-slurry. Significantly the highest spike length (11.20 cm), number of spike/m^2 (331 cm) and number of grains per spike (53.67) were recorded in 100% RF+Bio-slurry 10 t ha^{-1} treatment combination. But significantly higher 1000 - grain weight (52.33 g) was found in 75% RF+Bio-slurry 10 t ha^{-1} treatment. Significantly the highest yield (3.86 t ha^{-1}) was recorded in 100% RF+ Bio-slurry 10 t ha^{-1} treatment combination which is statistically similar to that of 75% RF+Bio-slurry 10 t ha^{-1} (3.84 tha^{-1}) treatment combination. The lowest yield contributing characters were recorded when no bio slurry was applied but only 50% recommended doses of fertilizers were applied. Gross return (Tk.96000 /ha) and benefit cost ratio (2.87) was higher in 75% recommended doses + bio-slurry 10 tha^{-1}. Grain yield of wheat is higher in 100% of RF + Bio-slurry 10 t ha^{-1} treatment but gross return and benefit cost ratio was lower due to total cost of production was highest (35000 Tk./ha). Hence, 10 tha^{-1} bio-slurry + 75% of the recommended doses of fertilizers combination would be economically profitable.

Response of hybrid maize to different sources of nitrogen

The experiment was carried out at Regional Agricultural Research Station, Rahmatpur, Barisal during *rabi* season of 2013-14 to find out the optimum doses of USG to hybrid maize for the southern region of Bangladesh. The experiment was laid out in a randomized complete block design with three replications. Seven treatments were tested viz. Prilled urea, 100% USG as basal, 80% USG as basal, 100% USG at 15 DAE (Days after emergence), 80% USG at 15 DAE (Days after emergence), 100% USG at 30 DAE, 80% USG at 30 DAE. Seeds were sown on25November, 2014 with spacing 60 cm × 20 cm. In Prilled urea, one third of N and other fertilizers were applied in the final land preparation and rest of N were applied as top dressed at 35 DAS. Among the treatments, 100% USG as basal gave the highest yield (11.06 t ha^{-1}) due to higher number grains cob^{-1} and 1000- grain wt. and the lowest yield (6.75 t ha^{-1}) was recorded in 80% USG at 30 DAE due to delay application of fertilizer. But Prilled urea , 100% USG as basal and 80% USG as basal gave statistically similar grain yield.

Higher benefit cost ratio (2.70) was observed from 80% USG as basal compared with other treatments. But maximum cost of cultivation (Tk. 61425 /ha) was observed where application of 100% USG as basal, application of 100% USG at 15 DAE and application of 100% USG 30 DAE and the minimum (Tk. 55475/ha) in where application of 80% USG as basal.

Effect of sowing depth in wheat

The experiment was carried out at Agricultural Research Station, Rajbari, Dinajpur during 2014-15 to study the effect of sowing depth on emergence, tillering ability and yield of wheat. The treatments were four sowing depth such as 2, 4, 6 and 8 cm. Seeds of BARI Gom 26 were sown on November 30, 2014, respectively. Seeds were placed continuously in lines as per treatment depth by making specific narrow furrows with iron rod and covered with soil by hand. Fertilizers were applied @ 100-60-40-20-1 kg ha^{-1} N-P_2O_5-K_2O-S in the form of urea, triple super phosphate, muriate of potash and gypsum, respectively. Two-third of urea and total amount of other fertilizers were applied during final land preparation. The rest amount of urea was top dressed at crown root initiation (CRI) stage. Sowing depth affect significantly on seedling emergence and stand establishment in wheat. Seeds sowing in 4 cm depth recorded the highest number of seedling emergence throughout the counting period and the lowest number was recorded in seeds sowing 2 cm and 8 cm depth. The maximum root dry weight was recorded in 2 cm depth which was statistically at par with 4 cm and 6 cm depth and the lowest in 8 cm depth. Yield and yield contributing attributes of wheat varied significantly by sowing depth. The highest spikes m^{-2} was recorded in 4 cm depth and the lowest in 2 cm and 8 cm depth. The highest (4.48 t ha^{-1}) grain yield was recorded in 4 cm depth due to the highest number of spikes m^{-2} and the lowest in 2 cm and 8 cm depth.

Effect of tillage and plant population on growth and yield of hybrid maize

The experiment was conducted at farmer’s field, Moulovibazar, Gangachara, Rangpur under ARS, Burirhat, Rangpur during rabi season 2012-13 and 2013-14 to find out optimum tillage and planting technique for higher yield of hybrid maize and to reduce cultivation cost in maize production. The soil of the experimental plot was sandy loam in texture.The design followed for the experiment was RCB with 3-replications.The six treatments were as follows: T_1: Zero tillage/Dibling + one seed/hill, T_2: Zero tillage/Dibling + two seed/hill, T_3: Minimum tillage (One plough with power tiller) + one seed/hill, T_4: Minimum tillage (One plough with power tiller) + two seed/hill, T_5: Conventional tillage (Three plough with power tiller) + one seed/hill, T_6: Conventional tillage (Three plough with power tiller) + two seed/hill. The size of the unit plot was 5m × 4.2m and spacing maintained 60cm × 20cm. One plough and three plough with power tiller were done respectively for minimum tillage and conventional tillage. Seeds were sown in line opening furrow except dibling treatments. Seeds of hybrid maize (NK- 40 in 1st year and BHM-7 in 2nd year) were sown on 17 December, 2012 and 20 December, 2013 immediate after aman rice harvest. At 15 DAE one plant/hill was kept in the plot. Fertilizers were applied at the rate of 255-55-110-40-5-1.5 kg/ha NPKSZnB. Half of urea and all other fertilizer was applied as basal. In case of zero tillage basal fertilizer was applied one day before sowing of maize through irrigation. Rest urea was applied as top dressed in two equal splits at 35 and 65 DAS. The maize was harvest on May 16, 2013 in 1st year and May 17, 2014 in 2nd year. It was observed that yield and yield components of maize did not vary significantly in different treatments in the year of 2012-13 and 2013-14. Considering the economic performance the highest gross margin and benefit cost ratio were found in zero tillage/Dibling + one seed/hill treatment in both the years.

Performance of hyrid maize preceded by T. Aman rice under zero tillage-soil mulch condition

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2014-2015 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) were included in the experiment. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 5m × 3m. The crop was sown on 06 December 2014 (just after harvest of T-aman rice) and harvest on 28 April 2015. Fertilizer was applied @ 254-52-110-47-5-1kg ha^{-1} of N-P-K-S-Zn-B. One third nitrogen and full amount of other fertilizer were applied as basal before dibbling of maize. Rest of the nitrogen was top dressed in two equal split at 50 and 70 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. Two hand weeding were done at 55-60 and 85-90 days after emergence. The highest maize grain yield was obtained from BHM 9 (6.71 t ha^{-1}) and BHM 7 (6.54 t ha^{-1}) and the lowest grain yield was given from BHM 3 (4.69 t ha-1). BHM 7 and BHM 9 gave the better yield performance preceded by T-aman rice under zero tillage-soil mulch condition at Ishwardi region.

Weed Management

Effect of tillage method and weed management on the yield of hybrid maize

The field experiment was conducted at the Agronomy research field of Bangladesh Agricultural Research Institute (BARI) during December 2014 to April 2015 to evaluate the weed control option along with different tillage methods in controlling weeds in maize field. Treatments consisted of two tillage method (conventional tillage and strip tillage) and six weed control methods [W_0= No weeding, W_1= hand weeding at 25 and 45 DAE of maize, W_2= Eon phosate application as pre-emergence herbicide (10 days before sowing @ 100 ml/10 litre H_2O), W_3= AIM (Cerfentrazone ethyle 40 DF) application as post emergence herbicide @ 3g/14 litre H_2O at 25 DAE of maize, W_4= Ritweed application as post-emergence herbicide @ 74 ml/10 litre H_2O at 25 DAE of maize and W_5= W_2 + W_4]. The experiment was laid out in a split-plot design with three replications. The tillage method was arranged in the main-plot and weed control methods in the sub-plot. Fertilizers at the rate of 298 kg N, 88 kg P, 141 kg K, 63 kg S and 5 kg Zn/ha was applied in the form of urea, triple super phosphate, murate of potash, gypsum, and zinc sulphate, respectively. Full dozes of triple super phophate, murate of potash, gypsum, zinc sulphate and 1/3rd of urea were applied at the time of final land preparation in conventional tillage but in furrow in the strip tillage. The remaining 2/3rd urea was applied in two equal splits at 30 and 50 DAE followed by irrigation. Weedicide was sprayed as per treatments. Post-emergence herbicide was sprayed in the space between maize lines and maize plants were protected from direct conduct of herbicide by keeping hard board near maize plants. Seeds of maize (cv. BARI Hybrid maize 9) were sown on 7 December 2014 with a spacing of 60 cm × 20 cm. Weed samples were collected from each plot at 25 DAE using a quadrate and dry weight was recorded to evaluate the efficacy of different weed control treatments in both tillage methods. *Chenopodium album* was observed as a major weeds (44.33%) in maize field. About 24.76 different weeds were found to compete with the single maize plant where 10.98 was *Chenopodium album.* The higher number of weeds were observed in plot of strip tillage than conventional tillage irrespective of weed management options. Weed free treatment increased yield components and yield of maize irrespective of tillage method. Heal storm for consecutive two days were occurred at 115 DAS of maize which partially damaged the crop. So the yield of maize was poor in all the treatments.Hand weeding at 25 and 45 DAE, pre-emergence Eon phosate and post-emergence AIM application gave higher grain yield in both the tillage systems. These weed control options were also suitable in respect of gross return, net return and BCR.

Effect of different doses of herbicides for controlling weeds in maize field

A field trial was conducted at Agronomy Research field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during the period from November 2014 to April, 2015 to find out the optimum dose of herbicide to control weed in maize field. The treatments were: T_1 = spraying of Nirani @ 0.75 g/Lit water, T_2 = spraying of Nirani @ 1.00 g/Lit water, T_3 = spraying of Dipon @ 0.10 ml/Lit water, T_4 = spraying of Dipon @ 0.12 ml/Lit water, T_5 = two hand weeding at 25 & 50 DAE (Days After Emergence), T_6 = control (no spray or hand weeding). The trial was set up in randomized complete block design with three replications. Seeds of maize (Var. BARI Hybrid maize 9) were sown on 23 November 2014. The unit plot size 3m × 5m. The crop was fertilized with cowdung 5 t/ha, 250-55-110-40-5-1.5 kg ha^{-1} N-P-K-S-Zn-B (FRG 2012) in the form of Urea, TSP, MoP, Zypsum, $ZnSO_4$ and Boric acid, respectively. One third of urea and all other fertilizers were applied during final land preparation. Remaining 2/3 urea were top-dressed in two equal splits at 30 and 60 DAE followed by irrigation. Since these are the pre emergence herbicides, so herbicide spraying was done before one week of sowing of maize seed. The crop was harvested on 20 November 2015. Results showed that number of weed/m^2, weed control efficiency (WCE), number of seed/ cob, 1000 seeds weight and yield of maize were significantly influenced by different weed management methods. Mutha (*Cyperus rotundus*), Helencha (*Enhydra fluetuans*), Shama (*Echinochola crusgali*), were the common weeds in the maize field. Among the weed species Mutha (*Cyperus rotundus*), Shama (*Echinochola crusgali*) were the dominant weed. The highest 51, 151 (weeds/m^2) were recorded in control plot at 25 & 50 DAE, respectively. The lowest 9.7 & 41weed/m^2 were recorded in T_2 treatment. The highest WCE (weed control efficiency) 90.38% & 84.35% was found in T_2 treatment at 25 & 50 DAE, respectively followed by T_4 treatment. The highest no of seeds/cob (457.07), 1000 seeds weight (333g) and yield (7.26 t/ha) was obtained from T_5 treatment which was at par with T_2 (6.56 t/ha) and T_4 (6.13 t/ha). The lowest was found in T_6 (control) treatment. Although treatment T_5 showed the highest yield but the highest net return (Tk. 96200/ha) and BCR (3.74) was obtained from the treatment T_2 for its low cost of cultivation. The result revealed that spraying of herbicide Nirani @ 1.00 g/Lit water would be the most effective to control weeds for obtaining higher yield and economic return for maize production.

Effect of weed management on the yield of green chilli

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chittagong during rabi season of 2015 to determine the effect of weed management on the yield of green chilli. The experiment was laid out in a Randomized Complete Block Design with four replications. The unit plot size was 3m × 5m. There were 5 treatment combinations were used in this experiment viz; T_1= no weeding, T_2= one weeding at 15 DAT, T_3= two weeding at 15 & 30 DAT, T_4= three weeding at 15, 30 & 45 DAT, T_5= pre-emergence herbicide (roundup). All fertilizers except N were applied at the tine of final land preparation. Nitrogen was top dressed in 4 equal splits at 5, 30, 55 and 75 days after planting followed by light irrigation. About one month old seedlings of chilli (local) were transplanted on last week of December maintain a spacing of row to row 40 cm and plant to plant 30 cm. Intercultural operations and plant protection measures were done to keep the plant healthy as and when necessary. Green chilli was harvested at mature stage. Results revealed that the T_4 (three weeding at 15, 30 & 45 days after transplanting) produced the highest fruit yield of 6.25 t ha^{-1} and the lowest 3.67 t ha^{-1} in no weeding treatment. BCR and yield contributing parameters were the highest in the treatment of three weeding at 15, 30 & 45 days after transplanting.

Multiple Cropping

Effect of sowing date of sweet corn on potato + sweet corn intercropping system

An experiment was conducted at the Agronomy research field of BARI,Joydebpur, Gazipur and at Regional Agricultural Research Station, BARI, Burirhat, Rangpur during Rabi season of 2013-14 and 2014-15 to find out appropriate sowing date of sweet corn in potato + sweet corn intercropping for getting maximum yield and economic return. Six treatments namely simultaneous sowing of potato and sweet corn, sweet corn sown 10 days after potato planting (DPP), sweet corn sown 20 DPP, sweet corn sown 30 DPP, sole potato and sole sweet corn were tested in this study. The experiment was laid out in randomized complete block design with three replications. BARI Alu 7 (Diamant) variety of potato and BARI Sweet corn 1 variety of sweet corn was used in this experiment. Potato was planted on 24 and 17 November 2013 and 2014, respectively at Joydebpur and 20 November 2013 and 17 November 2014 at Rangpur and sweet corn was sown according to the treatments. Sole potato and sole sweet corn were also planted on same date in both locations. Potato was planted with 60 cm × 25 cm spacing in sole and 75 cm × 20 cm spacing in intercrop situation. Sweet corn was sown with 75 cm × 20 cm spacing both in sole and intercrop situation. In intercrop treatments, one row of sweet corn accommodated in between two rows of potato. For sole potato and sole sweet corn fertilizers were applied @ $N_{180}P_{40}K_{180}S_{20}Zn_{6}B_{1.2}$ and $N_{160}P_{50}K_{100}S_{40}Zn_{4}B_{2}$ kg/ha, respectively (FRG, 2012). For intercrop fertilizers were applied @ $N_{320}P_{73}K_{170}S_{50}Zn_{6}B_{2}$ kg/ha. The source of N, P, K, S, Zn and B was urea, TSP, MoP, gypsum, zinc sulphate and boric acid, respectively. In case of sole potato, half amount of urea and MoP and the whole amount of TSP, gypsum, zinc sulphate and boric acid were applied at the time of final land preparation. Remaining 1/2 amount of urea and MoP were applied at 30 days after planting (DAP). For sole sweet corn, one-third of urea and whole amount of other fertilizers were applied at the time of final land preparation. Remaining 2/3 amount of urea was applied in two equal splits as side dressing at 30 and 55 days after sowing (DAS). In case of intercrop, one- third urea and ½ of all other fertilizers were applied as basal. One-third urea and rest of all other fertilizers were side dressed at 30 DAP of potato and rest of urea was side dressed just after potato harvest followed by irrigation. Irrigation and other intercultural operations were done as and when required. Fungicide (Dithane M-45) was sprayed at every 10-day intervals beginning from 25 to 70 DAP for preventing potato disease. All necessary data were taken at harvesting. Potato was harvested on 22 and 15 February 2014 and 2015, respectively at 90 DAP at Joydebpur and at Rangpur potato was harvested on 25 February 2014 and February 23, 2015. Sweet corn was harvested at 115-120 DAS in both locations. Economic analysis was also done considering local market price of harvested crops. Sweet corn sown 20 days after potato planting produced the highest potato equivalent yield (at Joydebpur 41.41 t/ha in 2013-14 and 42.22 t/ha in 2014-15 and at Rangpur 42.29 t/ha in 2013-14 and 42.52 t/ha in 2014-15), gross return (at Joydebpur TK 426925/ha in 2013-14,TK 435175/ha in 2014-15 and at Rangpur TK 422940/ha in 2013-14, TK 425240/ha in 2014-15), gross margin (at Joydebpur TK 282680/ha in 2013-14, TK 290930/ha in 2013-14 and at Rangpur TK 251790/ha in 2013-14, TK 254090/ha in 2014-15) and benefit cost ratio (at Joydebpur 2.96 in 1st year, 3.02 in 2nd year and at Rangpur 2.47 and 2.48 in 1st and 2nd year, respectively). In this treatment, tuber yield was reduced 3.4-4.1% in Joydebpur and 7.8-8.4% in Rangpur due to intercropping. The result indicated that sweet corn sown 20 days after potato planting might be suitable intercrop combination for getting maximum yield and economic net return.

Intercropping lentil with brinjal at varying planting geometry

A field experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur during *rabi* season of 2013-14 and 2014-15 to find out suitable intercrop combination of lentil with brinjal for getting higher yield and economic benefit. Four intercropping combinations, viz. T_3 = Brinjal (100%) + Broadcast lentil (100%) in between two rows of brinjal, T_4= Brinjal (100%) + 2 rows lentil in between two rows of brinjal, T_5 = Brinjal (100%) + 3 rows lentil in between two rows of brinjal and T_6 = Brinjal (100%) + 4 rows lentil in between two rows of brinjal were compared with T_1 = Sole Brinjal (75 cm × 60 cm) and T_2 = Sole lentil (30 cm × 5 cm). The experiment was laid out in Randomized Complete Block Design with three replications. Seeds of lentil (var. BARI Masur 6) and brinjal seedling (cv. BARl Begun 10) were sown/ transplanted on 15 November, 2013 and 06 November, 2014. For sole lentil and intercrop fertilizers @ 28-18-20-4-1 kg ha^{-1} NPKSB were applied at the time of final land preparation in the form of Urea, TSP, MoP, gypsum and boric acid, respectively. For sole brinljal 160-48-120-20-3-0.9 kg ha^{-1} NPKSZnB were used. Except N & K, full amount of other fertilizer were applied in pit before 1 week of transplantation. N & K was applied in 3 equal splits at 21, 35 & 50 DAT as ring method followed by irrigation. Brinjal yield was greatly influenced by lentil population; increase of lentil population reduced brinjal yield.Intercropping reduced brinjal yield by 5.10 to 22.09 % in 2013-14 and 0.16 to 11.83% in 2014-15 respectively but total productivity was increased due to addition of lentil yield. Total productivity which is expressed in brinjal equivalent yield (BEY) was increased due to intercropping. In both the years (2013-14 and 2014-15 respectively) the highest brinjal equivalent yield (41.81 t ha^{-1} and 40.36 t ha^{-1}), gross return (Tk 6,27,085 ha^{-1} and Tk 6,05,440 ha^{-1}), gross margin (Tk. 4,13,924 ha^{-1} and Tk. 3,92,279 ha^{-1}) and benefit cost ration (2.94 and 2.84) was obtained from Brinjal (100%) + 2 rows lentil in between two rows of brinjal (T_4 treatment) and it might be agronomically feasible and economically profitable for brinjal growing farmer's.

Intercropping bush bean and red amaranth with sweet corn

An intercropping experiment was conducted at research field of Agronomy division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* season of 2014-15 to find out suitable planting systems of sweet corn, red amaranth and bush bean intercropping system. Seven treatment combinations viz. T_1= sweet corn (normal row) + red amaranth 2 lines with bush bean single row, T_2= sweet corn (normal row) + red amaranth 3 lines with bush bean double row, T_3= sweet corn (Paired row) + red amaranth 4 lines with bush bean 3 rows, T_4= sweet corn (Paired row) + red amaranth 5 lines with bush bean 4 rows, T_5= Sole red amaranth, T_6= Sole bush bean and T_7= Sole sweet corn were tested. The experiment was laid out in a randomized complete block design with three replications. The sweet corn (var. BARI Sweet corn-1), red amaranth (BARI lalshak-1) and bush bean (BARI Jhursem-1) were used in this intercropping experiment. Seeds of sweet corn, red amaranth and bush bean were sown 19 November, 2014 according to treatments. Sole sweet corn and intercrop were fertilized with 122-43-60-26-5-1.5 kg/ha NPKSZnB (FRG, 2012). One third urea and all other fertilizers were applied as basal and rest urea was applied at 25-30 DAP and 55-60 DAP. In red amaranth fertilizers were applied @70-15-45-15 kg/ha NPKS (FRG, 2012) through urea, TSP, MoP and gypsum, respectively. Sole bush beans were fertilizered according to BARI recommendation. Weeding, irrigation and other intercultural operations were done as and when necessary. Yield of sweet corn, red amaranth and bush bean were higher in respective sole crops. The highest sweet corn equivalent yield (27.16 t/ha), gross return (TK. 407400/ha), gross margin (Tk. 163155 /ha) and benefit cost ratio (1.81) were achieved from T_2 treatment [sweet corn (normal row) + red amaranth 3 lines with bush bean double row] followed by T_4 treatment [sweet corn (paired row) + red amaranth 5 lines with bush bean 4 rows]. The result revealed that sweet corn (normal row) + red amaranth 3 lines with bush bean double row intercropping system would be economically profitable.

Intercropping mustard with lentil

The experiment was conducted at the Regional Agricultural Research Station, Rahmatpur, Barisal during *rabi* season of 2013-14 and 2014-15 to find out suitable intercrop combination for higher productivity and economic return. Sole lentil (100%), sole mustard (100%) and five intercrop combinations viz., one row mustard + one row lentil (1:1), one row mustard + two row lentil (1:2), one row mustard + three row lentil (1: 3), one row mustard +four row lentil (1:4) and two row mustard + four row lentil (2: 4) were evaluated in the study. The experiment was tested in a randomized complete block design with three replications. The seeds of lentil (BARI Masur 6) and mustard (BARI Sarisha 15) were sown on November 19 and 20 in 2013 and 2014, respectively. Lentil sole and intercrop plots had received a uniform application of 50-90-40-102 kg NPKS /ha and sole mustard plot had received

250-175-90-160 kg NPKS/ha through urea, triple super phosphate (TSP), muriate of potash (MoP) and gypsum. In lentil and intercrop plots, all fertilizers were applied as basal. But in case of sole mustard plot, half of urea and full amount of TSP, MoP and gypsum were applied as basal and remaining half urea was applied before flowering at 30 days after sowing (DAS). Cow dung (5 t/ha) was applied as basal in all the plots. Intercultural operations like weeding, irrigation and plant protection measures were provided to both the crops as and when necessary. Lentil was harvested on 10 and 11 March in 2014 and 2015, respectively at 120 DAS. Economic analysis and benefit cost ratio (BCR) were also computed considering local market price of both crops. One row mustard + three row lentil (1: 3) produced the highest lentil equivalent yield (2.24 t/ha 2.28 t/ha in 1st and 2nd year, respectively), gross return (TK 179200/ha in 2013-14 and TK 182400/ha in 2014-15), net return (TK 100000/ha and TK. 103200/ha in 2013-14 and 2014-15, respectively) and benefit cost ratio (2.26 and 2.30 in 1st and 2nd year, respectively). Lentil yield was reduced (14-34%) due to intercropping over the years. The result indicated that one row mustard + three row lentil might be suitable intercrop combination in lentil mustard intercropping for getting maximum yield and economic return.

Inter mixed cropping of garden pea with onion

An experiment was conducted at the Regional Agricultural Research Station, Jamalpur during the *rabi* seasons of 2013-2014 and 2014-2015 to find out the optimum population of garden pea as inter mixed cropped with onion and maximize the land utilization and economic return. There were six treatments viz., T_1= Sole onion (Broadcast), T_2=Sole garden pea (30 cm × 5cm), T_3= 100% onion (Broadcast) + 80 % garden pea (37.5 cm × 5cm), T_4=100% onion (Broadcast) + 60 % garden pea (50 cm × 5cm) and T_5=100% Onion (Broadcast) + 40 % (75cm × 5cm) Garden pea , T_6=100% onion (Broadcast) + 50% garden pea (Broadcast). Design of the experiment was randomized complete block design with three replications. BARI Motorshuti 3 and BARI Piaj 1 were used. Onion seeds were sown on broadcast system @ 7 kg seed/ha while the garden pea was sown in a line. Fertilizers were applied for sole onion and intercrop at the rate of 60-30-80-20-2.0-0.7 kg/ha of N-P-K-S-Zn-B. For sole onion and intercropping systems half of nitrogen and all other fertilizer were applied during the final land preparation and half nitrogen was top dressed at 25 and 50 days after sowing (DAS) followed by irrigation. For sole garden pea: 30-14-20-6-0.7 kg/ha of N-P-K-S-Zn were applied at the final land preparation in the form of urea, TSP, MoP, gypsum and boric acid, respectively. For garden pea and onion irrigation was applied at 15 days after emergence. Onion was planted on 19 November, 2013 (1st year) and 19 November, 2014 (2nd year) while on the same day's different ratio of garden pea was sown in a line according to the treatment. Fresh garden pea was harvested at 60 and 65 DAS by hand picking on the basis of maturity. Yield of individual crop was converted into onion equivalent yield (OEY) considering prevailing market price. In 1st year trial, T_3 (onion 100% broadcast + 80 % garden pea) treatment produced the highest onion equivalent yield (19.71 t/ha), gross return (TK 421900/ha), gross margin (TK 290930/ha) and benefit cost ratio (3.76) followed by T_4 treatment and in 2nd year, T_4 (onion 100% broadcast + 60 % garden pea) treatment produced the highest onion equivalent yield (21.60 t/ha), gross return (TK 475200/ha), gross margin (TK 359220/ha) and benefit cost ratio (4.09) followed by T_3 treatment. LER was higher than one in all intercrop treatments and maximum LER (1.54) was found in T_3 in the first year and T_4 (1.68) in the second year. The result revealed that onion 100% (broadcast) + 60- 80% garden pea might be suitable intercrop combination for getting maximum yield and economic return.

Study on potato sunflower intercropping with relay mungbean

The experiment was conducted at the research field of Regional Agricultural Research Station Jamalpur during *rabi* season of 2014-2015 to find out suitable intercropping combination of sunflower and potato where mungbean can be grown as relay crop in sunflower for increasing productivity and economic return of existing potato-mungbean-T. Aman cropping pattern. Five intercropping combinations, viz T_2= 100 % potato + 1 row sunflower (plant to plant 25 cm) at 20 DAP of potato + 2 rows mungbean as relay between sunflower, T_3=100 % potato + 1 row sunflower (plant to plant 50 cm) at 20 DAP of potato + 2 rows mungbean as relay between sunflower T_4=100 % potato + 1 row sunflower (plant to plant 75 cm) at 20 DAP of potato + 2 rows mungbean as relay between sunflower T_5=100 % potato + 1 row sunflower (plant to plant 50 cm) at 30 DAP of potato + 2 rows mungbean as relay between sunflower T_6=100 % potato + 1 row sunflowers (plant to plant 75 cm) at 30 DAP of potato + 2 rows mungbean as relay between sunflower were compared with T_1=Sole Potato (60 cm × 25 cm). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Dimant, BARI Surjomukhi 2 and BARI Mung 6 were used in this experiment. Potato seeds were planted by the hand dibbling on 26 November, 2014 maintaining the spacing at 60 cm x 25cm, sunflower seeds were planted as per treatment. After harvesting of potato mungbean seeds were sown as per treatment without mechanical disturbance of soil maintaining the spacing 30 cm (L-L). Fertilizers were applied @ 135-30-135-15-10-4-0.8 kg ha^{-1} NPKSMgZnB alon with cow dung 4 t ha^{-1}. Half N and K and full quantity of other fertilizers were applied at the time of final land preparation in the form of urea, Triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid respectively. Remaining half N and K were side dressed at 35 days after planting. Total productivity in terms of potato equivalent yield (PEY) was increased due to intercropping. The highest PEY (28.3 t ha^{-1}) and maximum gross return Tk. 366700 ha^{-1} was obtained from T_3 treatment but the highest gross margin Tk. 262830 ha^{-1} was found in T_6 treatment and the maximum BCR (3.90) was found in T_1 treatment due to lower cost of production.

Fertilizer management of hybrid maize after potato harvest

The experiment was conducted at RARS, Burirhat, Rangpur during *rabi* season of 2014-15. The five treatments were as follows for maize crop: T_1) Recommended dose, T_2) 75% of recommended dose, T_3) 50% of recommended dose, T_4) 25% of recommended dose, T_5) Farmers practices (1 kg urea $decimal^{-1}$ at the vegetative growth stage). The spacing maintained 60 cm. × 20 cm. The design followed for the experiment was RCB with three replications. Potato tuber were sown on 13 November 2014 in line. The variety was diamant. The fertilizers of potato was used as recommended by FRG, 2012. Potato was harvested on 06 March, 2015. After potato harvest, the maize seeds was sown on 07 march, 2015. The test variety was BARI Hybrid maize 9. The recommended fertilizer dose of maize was 275-54-140-5-1.5 kg ha^{-1} N P K Zn & B. All fertilizers and 1/3 urea were applied as basal and the rest of urea was used at the 30 and 60 DAS.The highest grain yield of maize (11.97 t ha^{-1}) was recorded in recommended dose of fertilizers (T_1) which was identical with T_2 (75% of recommended) and T_3 treatments. The tuber yield of potato was around 33 to 26 t ha^{-1} in the year 2013-14 and 2014-15, respectively when applied recommended fertilizers. The results revealed that 50% of recommended dose of fertilizers for maize would be better after potato harvest.

Effect of leafy vegetables and spices on the performance of potato and cucumber intercropping

The experiment was conducted at RARS, Burirhat, Rangpur during Rabi season of 2014-15. The treatments comprised of seven intercropping system viz. T_1) sole potato (60 cm × 25 cm), T_2) 100% potato+100% cucumber, T_3) 100% potato + 2 rows onion (plant to plant 10 cm)+1 row cucumber (pit to pit 2m), T_4) 100% potato+2 rows radish (plant to plant 30 cm)+1 row cucumber (pit to pit 2m), T_5) 100% potato+2 rows red amaranth (line sowing)+1 row cucumber (pit to pit 2m), T_6) 100% potato+2 rows spinach (Continuous sowing) + 1 row cucumber (pit to pit 2m) and T_7) 100% potato+2 rows garlic (plant to plant 10 cm)+1 row cucumber (pit to pit 2m). The design was followed RCB with three replications. Potato was sown on 22 November, 2014. Onion, garlic, radish, red amaranth and spinach were sown at the time of potato sowing. Cucumber planted on 27 December. The varieties of different crops were diamant of potato, BARI Mula-1 of radish, hybrid variety of cucumber, BARI Lalshak-1 of red amaranth, Local variety of garlic. The spacing for different crops were maintained as Potato: 60 cm × 30 cm, Radish: Plant to plant 30 cm, Cucumber pit to pit 2 m, Red amaranth: two lines between two potato rows and same case in spinach, onion and Garlic: plant to plant 10 cm. The fertilizers were 150-45-135-15-10-4-0.8 kg ha^{-1} of NPKSMgZnB and cowdung 5 t ha^{-1} (for potato). Half of N and K and all other fertilizers were applied at final land preparation. Remaining ½ N and K were side dressed at 25–DAP with irrigated condition. Other managements were done as when required.The highest potato equivalent yield of 42.03 and 65.43 t ha^{-1} was recorded in 100% potato + 2 rows onion + 1 row cucumber (T_3) treatment in the year 2013-2014 and 2014-2015 respectively. The lowest potato equivalent yield of 27.40 and 27.16 t ha^{-1} was obtained from sole potato (T_1) treatment in the year 2013-2014 and 2014-2015 respectively. The highest BCR of 2.87 and 3.78 was obtained from 100% potato + 2 rows radish + 1 row cucumber intercropping and 100% potato + 2 rows spinach + 1 row cucumber intercropping in the year 2013-2014 and 2014-2015, respectively.

Performance of transplanting maize as intercrop between potato rows

A field experiment was conducted at Regional Agricultural Research Station, BARI, Burirhat, Rangpur during *rabi* seasons of 2013-14 and 2014-15 to observe the effect of transplanting maize seedling between potato rows on the performance of potato + maize intercropping. The treatments were T_1= Sole potato, T_2= Sole maize (seed sown), T_3= Sole maize (Transplanted: 14 day's seedlings), T_4= Maize sown at 14 days after potato planting (DAP), T_5= Maize sown at 28 DAP, T_6= Maize transplanting (14 day's seedling) at 28 DAP, T_7= Maize transplanting (21 day's seedling) at 28 DAP. The experiment was laid out in a RCB design with 3 replications. BARI Alu 7 variety of potato and BARI hybrid Maize 9 variety of hybrid maize were used in this study. Potato was planted on November 21, 2013 and November 24, 2014 with spacing 60 cm × 25 cm. Spacing for sole and intercropped maize were 60 cm × 20 cm and 60 cm × 25 cm, respectively. Recommended doses of fertilizer for potato (115-30-125-25-2-1.5) and maize (254-52-110-45) kg/ha N-P-K-S-Zn-B (Razzaque *et. al.*, 2000) were used. In sole potato, ½ of N and full amount of PKSZnB were applied as basal in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. The remaining N was top dressed at 30 days after potato planting followed by irrigation. In sole maize, 1/3 of N and full amount of PKSZnB were applied as basal and rest N was top dressed in two equal splits at 30 and 60 DAE of maize. Potato tubers were harvested on February 28, 2015. All intercropping treatments gave higher equivalent yield and monetary return than sole crops. Transplanting maize into potato field with 14 days old seedling at 28 DAP (T_6) produced the highest potato equivalent yields (35.41 t/ha in 2013-14 and 40.51 t /ha in 2014-15), gross return (Tk.354120/ha in 2013-14 and Tk. 405100/ha in 2014-15), gross margin (Tk.187370/ha in 2013-14 and Tk. 233350/ha in 2014-15) and benefit cost ratio (2.12 in 2013-14 and 2.36 in 2014-15) which was followed by T_7 (Transplanting maize into potato field with 21 days old seedling at 28 DAP) treatment. The result revealed that transplanting maize into potato field with 14 and 21 days old seedling at 28 DAP might be suitable intercrop combination for getting maximum yield and economic return.

Intercropping chili with sweet gourd through fertilizer management

The experiment was conducted at the Farm of RARS, BARI, Burirhat, Rangpur during the *rabi* seasons of 2012-13 and 2013-14 with the objective to find out the optimum fertilizer dose for chili + sweet gourd intercropping system for higher productivity and economic return. Six different treatments viz; T_1=100% Sweet gourd (2 m × 2 m) + 40% chili (50 cm × 100 cm) + 100% RF of chili, T_2= 100% Sweet gourd+40% chili (50cm × 100cm) +75% RF of chili, T_3= 100% Sweet gourd+40% chili (50cm × 100cm) +50% RF of chili, T_4=100% Sweet gourd+50% chili (50cm × 80cm) +100% RF of chili, T_5= 100% Sweet gourd+50% chili (50cm × 80cm) +75% RF of chili and T_6= 100% Sweet gourd+50% chili(50cm × 80cm) +50% RF of chili were included in the study. The experiment was laid out in a randomized complete block (RCB) design with three replications. Recommended fertilizer dose for chilli was 120-80-120-20- 4kg/ha NPKSZn Kg + 10 ton cowdung and for sweet gourd was 146 -25-82 Kg/ha NPK. Fertilizer was applied as per treatment. For intercrop, half N and full amount of other fertilizer was applied as basal. Rest of N was applied in three equal split as ring dressing at 25, 50 and 70 days after transplanting. On the other hand, 10 days before sweet gourd transplanting, 4 kg cowdung, 10 g P and 17.5 g k were applied per pit as basal. At 10 DAT, 7 g P + 15 g K, at 30 and 50 DAT; 16.13 g N and at 70 DAR 9.22 g N were applied as ring dressing followed by irrigation. Fifteen days old seedling of BARI mistikumra 2 and 30 days old seedling of Manikgonj local were transplanted on 09 December 2012 and 05 December 2013, respectively. Intercultural operations like watering, weeding and spraying of insecticides and fungicides were applied when required. 100% Sweet gourd + 50% chili + 75% RF of chili (T_5 treatment) gave the highest sweet gourd yield (21.79 t ha^{-1} in 2012-13 and 22.52 t ha^{-1} in 2013-14) and yield of chili (9.21 t ha^{-1} in 2012-13 and 7.80 t ha^{-1} in 2013-14). Among the different inter cropping systems and fertilizer management, 100% sweet gourd + 50% chili + 75% RF of chili gave the highest sweet gourd equivalent yield (44.82 t $ha^{-1}$and 42.02 t ha^{-1}), gross return (Tk.268890 ha^{-1} and Tk.252120 ha^{-1}), gross margin (Tk. 206640 ha^{-1} and Tk. 189870 ha^{-1}) and BCR (4.32 and 4.05) in both the year. It might be concluded that 100% Sweet gourd + 50% chili + 75% RF of chili and 100% Sweet gourd + 40% chili (50cm × 100cm) + 75% RF of chili might be suitable for getting maximum yield and economic return.

Hybrid maize and chili intercropping under different planting systems

The experiment was conducted at RARS, Burirhat, Rangpur during *rabi* seasons of 2012-13 and 2013-14 respectively to find out suitable planting systems of hybrid maize and chili intercropping system for higher productivity. Four intercropping combinations, viz.T_1: Maize single row (100 cm × 25 cm) + 2 row chili (50 cm × 40cm), T_2: Maize single row with 2 plant/hill (100 cm × 50 cm)+2 row chilli (50 cm × 40cm), T_3: Maize single row (150 cm × 25 cm)+3 row chilli (50 cm × 40cm), T_4: Maize single row with 2 plant/hill (150 cm × 50 cm)+3 row chilli (50 cm × 40cm) were compared with T_5: Sole maize (60 cm×20 cm) and T_6: Sole chili (50 cm × 40 cm). The experiment was laid out in RCB design with three replications. Seeds of maize (BARI hybrid maize 7 in 1st year and BHM-9 in 2nd year) and 30 days aged seedling of local chilli were sown/transplanted on 11 December 2012 and 10 December 2013respectively. For sole maize, the land was fertilized at the rate of 250-55-110-40-4-2 NPKSZnB kg/ha. Half N and all other fertilizer was applied as basal. Rest N was applied at 30 DAS. In sole chilli the land was fertilized at the rate of 120-80-120-20-4 NPKSZn kg/ha. Half N and all other fertilizer was applied as basal. Rest N was applied in 3 splits at 25, 50 and 70 DAS as ring method. In case of intercrop, the land was fertilized at the rate of 370-55-110-40-4-2 NPKSZnB kg/ha. One-third N and full amount of other fertilizers were applied at the time of final land preparation. The rest N was applied in three equal splits at 25, 50 and 70 DAS. The highest number of plant/m^2 of maize (7.83 in 2012-13 and 6.92 in 2013-14) was recorded from the sole maize (T_5). Significantly the highest yield (9.16 t/ha in 1st year and 10.33 t/ha in 2nd year) was recorded from the treatment T_5 (sole maize) than the other treatments and the lowest was in T_4 treatment. The highest green chilli yield (8.30 t/ha in 2012-13 and 7.65 t/ha in 2013-14) was recorded from sole chilli plot (T_6) which was significantly higher than all other treatments. All the intercrop treatments showed better performance than the sole crop in both the year. Total productivity which is expressed in Maize equivalent yield (MEY) was increased due to intercropping. The highest gross return (Tk 167070/ha in 2012-13 and Tk 175280/ha in 2013-14), gross margin (Tk 108820 /ha in 2012-13 and Tk 117030/ha in 2013-14) and benefit cost ratio (2.87 in 2012-13 and 3.01 in 2013-14) were obtained from maize single row (100 cm × 25 cm) +2 row chilli (50 cm × 40cm). From two years results, it revealed that both the treatments maize single row (100 cm × 25 cm) +2 row chilli (50 cm × 40cm) and maize single row with 2 plant/hill (150 cm × 50 cm) + 3 row chilli (50 cm × 40 cm) might be suitable intercrop combination for getting maximum yield and economic return.

Intercropping of brinjal with different seeding ratio of leafy vegetables

The experiment was carried out at RARS, Burirhat, Rangpur during the *kharif* season of 2012 and 2013 to find out suitable crop combination for intercropping brinjal with leafy vegetables for higher productivity and economic return. Seven treatments such as T_1: Sole brinjal (100 cm × 75 cm), T_2: Brinjal (100%)+ Red-amaranth (100%broadcast between brinjal lines), T_3: Brinjal (100%)+ Red-amaranth (75% broadcast between brinjal lines), T_4: Brinjal (100%) + leaf amaranth (100% broadcast between brinjal lines), T_5: Brinjal (100%)+ leaf amaranth (75% broadcast between brinjal lines), T_6: Brinjal (100%) + BINA Patshak (100% broadcast between brinjal lines), T_7: Brinjal (100%)+ Bina Patshak (75% broadcast between brinjal lines) were used in the study. The experiment was laid out in a RCB design with 3 replications. BARI Begun 8 was the test cultivar. The seeds of leafy vegetables were broadcasted and brinjal seedlings of 30 days were transplanted on April 23, 2012 and on April 29, 2013. For sole brinjal & intercrop cowdung 10 t/ha and N-P-K-S-Zn-B @ 120 -36-90-15-2-0.5 Kg/ha were applied. Half cowdung was applied during final land preparation. Remaining cowdung and full P, S, B and Zn were applied in pit before one week of transplanting. N and K were applied in three equal splits at 21, 35 and 50 DAT as ring method around the brinjal plants followed by irrigation. Leafy vegetables were harvested at 30 DAS in both the year and brinjal was harvested during June to September, 2012 and 2013. The highest fruit yield of brinjal was found in T_1 treatment (Sole brinjal) in both the years. Among the intercrop, higher vegetable yield was found in brinjal and leaf amaranth intercropping system in both the year. The highest brinjal equivalent yield (28.73 t/ha in 2012 and 25.77 t/ha in 2013) was obtained from T_5 treatment (Brinjal (100%)+ leaf amaranth (75% broadcast between brinjal lines). The highest gross return (Tk.718150 /ha in 2012 and Tk.644150 /ha in 2013), gross margin (Tk.560005 /ha in 2012 and Tk.486005 /ha in 2013) benefit cost ratio (4.54 in 2012 and 4.07 in 2913) were also obtained from T_5 treatment (Brinjal (100%)+ leaf amaranth (75% broadcast between brinjal lines) in both year. Two years results revealed that 100% brinjal with 75% leaf amaranth intercropping system might be suitable for maximum economic return.

Intercropping of sesame and mungbean with turmeric at varying population

An experiment was conducted during the *Kharif* season of 2014 at Regional Agricultural Research Station, Ishwardi, Pabna to find out the suitable intercrop combination of sesame/mungbean with turmeric for maximum economic return. Treatments were viz. T_1 = Turmeric (100%) + 1 row sesame (33%) in between turmeric lines, T_2 =Turmeric (100%) + 2 row sesame (67%) in between turmeric lines, T_3 =Turmeric (100%) + 3 row sesame (100%) in between turmeric lines, T_4 =Turmeric (100%) + sesame broadcast (100%) in between turmeric lines, T_5 =Turmeric (100%) + 1 row mungbean (33%) in between turmeric lines, T_6 =Turmeric (100%) + 2 row mungbean (67%) in between turmeric lines, T_7 =Turmeric (100%) + 3 row mungbean (100%) in between turmeric lines, T_8 =Turmeric (100%) + mungbean broadcast (100%) in between turmeric lines, T_9 =Sole turmeric, T_{10} =Sole mungbean and T_{11} =Sole sesame. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4.5m × 4m. Sesame/mungbean was intercropped in between turmeric row @ 33%, 67% and 100% population. The BARI Halud 4, BARI Til 4 and BARI Mung 6 were planting/sown on 22 March 2014 and harvested on 31 December, 26 June, 20-30 May 2014, respectively. Except broadcasting, sesame and mungbean seeds were sown in line (30cm apart row) following continuous seeding. The sole crop of turmeric and intercrops was fertilized with 140-54-117 kg/ha of N, P, K with 5 t/ha cowdung. In case of intercropping sesame with turmeric full amount of P, 1/3N and 1/2 of K with 5 t/ha cowdung were applied during final land preparation. Rest N was applied in three equal splits at 30, 95 and 120 days after planting/sown. Remaining K was applied at 95 and 120 days after planting/sown. In case of intercropping mungbean with turmeric full amount of P, 1/4N and 1/4 of K with 5 t/ha cowdung were applied during final land preparation. Rest N and K were applied three equal installments at 70, 100 and 120 days after planting/sown. Sole crop of sesame and mungbean were fertilized @ 60-30-25-20-2-2 kg/ha of N-P-K-S-Zn-B and 20-20-20 k/ha of N-P-K. In sole sesame ½ N and all other fertilizer was applied as basal. Rest N was top dressed at 30 DAS. In case of sole mungbean all fertilizer was applied as basal at final land preparation. Weeding and other intercultural operations were done as per requirement of the crops. After emergence, sesame was thinned keeping plant to plant distance of 5 cm. Earthing up of turmeric was done after harvesting sesame and mungbean. Data on yield and yield contributing characters were recorded and statistically analyzed. The mean values were adjudged by LSD test. It may be concluded that rhizome yield of turmeric produced higher yield in intercropping system than sole cropping. The highest economic return was found in the combination of turmeric (100%) + three line sesame (100%) in between two turmeric lines intercropping system

Intercropping garlic with brinjal

An experiment on intercropping of garlic with brinjal at different plant population was carried out at the Regional Agricultural Research Station, Ishurdi, Pabna during 2013 and 2014 to find out the efficiency the productivity of intercropping garlic with brinjal. Six treatments combination viz., Brinjal 100% + garlic 70%, Brinjal 100% + garlic 60%, Brinjal 100% + garlic 50%, Brinjal 100% + garlic 40%, Brinjal 100% + garlic 30% and Sole crop of brinjal were evaluated. The trial was set up in a randomized complete block design (RCBD) with three replications. The sole crop of brinjal and intercropped treatments were fertilized with cowdung 10 t/ha and 140-50-100-15-2-0.5 kg/ha N-P-K-S-Zn-B, respectively. One third of N, half of K and full amount of cowdung, P, S, B, Zn were applied during final land preparation. Remaining N and K were applied in three equal installments at 20, 40 and 60 days after transplants (DAT) as ring method around the brinjal plant. Brinjal (Var. BARI Begun 6) as base crop and garlic (Var. BARI Roshun 2) were used as intercrops in this study. The unit plot size was 4 m × 3 m. The sole crop of brinjal was planted at a spacing of 100 cm × 75 cm. In intercropping system 30%, 40%, 50%, 60% and 70% garlic were intercropped in between brinjal rows maintaining 15 cm × 10 cm plant spacing. Brinjal (thirty days old seedling) and seed of garlic were planted/sown on 10 and 16 November 2013 and 2014, respectively. Harvesting of brinjal was started on 20-25 February 2014 and 2015, respectively. Six irrigations were done in the experimental field. First was applied at just after transplanting (brinjal) and planting (component crop) of the crop. Second to fifth irrigation was applied at 30, 60, 90 and 120 days after transplanting and planting (DAT) of brinjal and garlic, respectively. Sixth irrigation was applied just after harvest of garlic. Weeding was done as per requirement. Data on yield and yield contributing characters were taken and analyzed statistically. The monetary return of intercropping of garlic with brinjal with different population was significantly higher as compared to sole cropping of brinjal. The highest gross return (Tk.1013426 /ha), gross margin (Tk.1384800/ha), BCR (3.73) and LER (2.59) were in intercropping of brinjal 100% + garlic 70% compared to other intercropping combination and sole cropping of brinjal. In terms of proper management practiced of brinjal plants 30% to 60% garlic population was more feasible compared to 70% garlic population with brinjal. Therefore, brinjal 100% + garlic 60% intercropping system may be recommended.

Relaying hybrid maize with T. Aman rice by different management practices

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2013-2014 and 2014-2015 to ensure optimum sowing time and to reduced cultivation cost. The experiment was laid out in a split plot design with three replications. Four plant spacing viz; S_1= 75cm

× 20cm, S_2= 60cm × 20cm, S_3= 50cm × 20cm and S_4= 40cm × 20cm were assign in the main plot and four management practices viz; M_1 = Soil mulching at 25 DAE, M_2= Earthing up at 25 DAE, M_3= Straw mulching at 25 DAE and M_4 = Without Earthing up and mulching (Control) were allotted in the sub plot . The unit plot size was 5m × 3m. The crop was relayed on 17 November 2013 and 4 November 2014 (ten days before the t-aman rice harvest) and harvest on 25 April 2014 and 15 April 2015, respectively. 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 were applied as basal before relay of maize seed at standing the T-aman rice. Rest nitrogen will be top dressed in two equal split at 50 and 70 days after emergence. Four irrigations were applied at 30, 60, 90 and 120 days after relay sowing, respectively. Two hand weeding were done at 55-60 and 85-90 days after emergence, respectively both the year. Data on yield and yield contributing characters were taken and analyzed statistically. The mean values were adjusted by LSD at 0.05 levels of probability. The treatment combination of 50cm × 20cm plant spacing with soil mulching at 25 DAE produced higher gross margin (Tk. 95200/ha) and BCR (2.17). The lowest gross margin (Tk.39800/ha) and BCR (1.44) were occurred in 75cm × 20cm plant spacing with straw mulching at 25 DAE. The highest maize grain yield (9.21 t/ha) was obtained from 50 cm × 20 cm plant spacing with earthing up at 25 DAE treatment. On the economic point of view plant spacing 50 cm × 20 with soil mulching at 25 DAE gave better performance with gross margin of Tk. 95200/ha and BCR of 2.17. It may be concluded that the treatment combination of 50cm × 20cm plant spacing with soil mulching at 25 DAE was more beneficial in respect of yield (9.21 t/ha), gross margin (TK 95200/ha) and BCR (2.17).

Relay mustard with T. Aman rice under different management at ishurdi region

The experiment was carried out during the *rabi* (winter) season of 2014-2015 at the Regional Agricultural Research Station, Ishurdi, Pabna. The soil was clay loam in texture. Two mustard varieties (BARI Sarisha 11 and BARI Sarisha 14) and three fertilizer management (F_1= Recommended doze 7 days before relaying time, F_2= Recommended doze at relaying time + at top dress ½ N at 1st irrigation and F_0= 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. The unit plot size was 3m × 4m. Fertilizer was applied as per treatments. Irrigation and crop management were performed as per recommendations. Mustard was sown on 18 November of 2014 before harvesting of Binadhan-7. BARI Sarisha 14 and BARI Sarisha 11 were harvested on 10 February and 23 February 2015, respectively. Five plants were collected randomly from each plot for yield component and yield data at maturity of the crop. Collected data were analyzed statistically with the help of MSTAT-C program and mean separation was done by LSD at 5% level of significance. Economic performance of the study was also evaluated. Plant population had no significant effect among the treatments. Plant population ranged 36-40 m^{-2}. The tallest plant height (145 cm) was observed from recommended doze at relaying time and top dress ½ N at 1st irrigation in BARI Sarisha 11 and the smallest plant height (47 cm) was recorded from farmer's practices in BARI Sarisha 14. The highest number of branches plant^{-1} (4.93) (Table 1). The highest Siliqua plant^{-1} (174) were observed from recommended doze at relaying time + top dress ½ N at 1st irrigation in BARI Sarisha 11 and lowest from farmers practices in BARI Sarisha 14 (Table 2.). The 1000-seed weight ranged between 2.60-3.40 g in BARI Sarisha 14 and 2.00- 3.00 g in BARI Sarisha 11. Recommended doze at relaying time and top dress ½ N at 1st irrigation treatment produced the highest grain yield (1633 kg ha^{-1} in BARI Sarisha 11) and the lowest grain yield (350 kg ha^{-1} in BARI Sarisha 14) from farmers practices. BARI Sarisha 11 showed better performance from recommended doze at relaying time with top dress ½ N at 1st irrigation treatment 7 days after sowing.

Unfavorable Eco-System

High Temperature

Impact of sowing date induced temperature and management practices on development events and yield of mustard

The experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during *rabi* season of 2014-2015 to find out the relationship between different development events of mustard crop and sowing dates induced temperature as well as to minimize the yield reduction by adopting appropriate management practices. The sowing dates were: i. 06 November (timely), ii. 25 November (late) and iii. 14 December (too late). The management practices were: i. Low: 60-15-30-10 kg NPKS ha^{-1}, no irrigation, no weeding, no pesticide. ii. Medium: 80-25-60-20 kg NPKS ha^{-1}, one weeding at 21 DAE, two irrigations at rosset and flowering stages, spraying pesticides. iii. High: 120-35-90-30 kg NPKS ha^{-1}, one weeding at 21 DAE, two irrigations at rosset and flowering stages, spraying pesticides. The sowing dates were assigned in the main plots and management practices were arranged in sub-plots. BARI Sarisha 15 was used as a test crop.

All developmental events varied due to variations on sowing dates and management practices. The events of emergence, first flowering and 50% flowering did not differ by management practices but differed by sowing dates. Planting of 25 November sowing took maximum days (6) for emergence and minimum took 06 November sowing (4 days). December sown plants took maximum days for first flowering (34 days) and 50% flowering (38 days) whereas 06 November sowing took minimum days for first flowering (29 days) and 50% flowering (35 days). The days for maturity varied by sowing date and management practices. The 06 November sowing took maximum days (80 to 83) and 14 December sowing took minimum days for maturity (74 to 78). Among the different dates of sowing, 06 November sowing accumulated maximum GDD of 89.70, 591.35 and 665.25°C for the events of emergence, first flowering and 50% flowering, respectively.

Developmental events were badly affected when sown on 14 December. Crop accumulated lower GDD for different development events when sown late. The minimum accumulated GDD of 72.15, 521.10 and 1070 to 1154 °C was observed for the events of emergence, 50% flowering and maturity on 14 December sowing, respectively. Late sowing took minimum time from flowering to maturity (36 days) due to increased of minimum temperature.

The highest seed yield was recorded from 06 November sowing with high management practices (1569 kg ha^{-1}). Contrary, the lowest seed yield (435 kg ha^{-1}) was obtained from 14 December sowing with low management practices due to increased temperature. Yield reduction at late sowing condition was reduced to some extent through adopting high management practices. At high management practices crop yielded 1183 kg ha^{-1} at 14 December sowing.

Phenology, growing degree days, growth and yield of mustard varieties

An experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during *rabi* season of 2014-2015 to find out the accumulated growing degree days (GDD) of different popular varieties of mustard for different plant developmental events and to estimate the dry matter production, growth and yield potentiality for the calibration of InfoCrop Modelling. In the experiment, four varieties of mustard were evaluated. These were: i. BARI Sarisha 14, ii. BARI Sarisha 15, iii. BARI Sarisha 11 and iv. BARI Sarisha 9. The experiment was laid out in a RCBD design with four replications. The soil was fertilized with 120-35-90-30 kg NPKS ha^{-1}. Seeds of all varieties were sown on Novemver 16, 2014 in lines with maintaining 30 cm row to row spacing. Admire 200SL @ 1 ml/liter of water was sprayed at 20 and 35 DAE to control Jassids and white flies. Rovral-50 WP @ 2 g/liter of water was sprayed at 30 and 45 DAE to control *Alternaria* diseases. Yield and yield contributing characters were recorded and analyzed statistically using STAR statistical tool for agricultural research, developed by International Rice Research Institute (IRRI) and mean separations were done by LSD test. Significantly the highest total dry matter was recorded in BARI Sarisha 11 almost at every stage which was followed by BARI Sarisha 9. The highest light interceptions by these two varieties were observed at 70 DAS such as about 40 and 32% in BARI Sarisha 11 and BARI Sarisha 9 respectively. The plant population was recorded significantly and it was the highest in BARI Sarisha 11 (61 m^{-2}) which was identical with the population of BARI Sarisha 14 (59 m^{-2}) and BARI Sarisha 15 (55.25 m^{-2}). The lowest population was recorded in BARI Sarisha 9 (51 m^{-2}). Significantly the highest seed yield was recorded in BARI Sarisha 11 (1567.59 kg ha^{-1}) and the second highest (1242.59 kg ha^{-1}) was found in BARI Sarisha 14 which was identical with BARI Sarisha 15 (1137.50 kg ha^{-1}) and BARI Sarisha 9 (1045.53 kg ha^{-1}). Among the varieties, BARI Sarisha 11 accumulated maximum GDD of 537.75, 618.85 and 1560.45°C for the events of first flowering, 50% flowering and maturity, respectively with maximum duration at all events. Significantly the highest seed yield was recorded in BARI Sarisha 11 (1567 kg ha^{-1}) followed by BARI Sarisha 14 (1242 kg ha^{-1}) which was statistically identical with BARI Sarisha 15 (1137 kg ha^{-1}) and BARI Sarisha 9 (1045 kg ha^{-1}). From the above findings, it may be concluded that BARI Sarisha 11 produced maximum dry matter and seed yield with maximum duration of vegetative and grain growth period with the accumulation of maximum GDD. Farmers can cultivate this variety for its highest yield (1567 kg ha^{-1}), provided they would not be able to grow boro rice. To fit in the tight schedule of cropping pattern (growing of boro rice) BARI Sarisha 14, which produced 1242 kg ha^{-1} could be recommended.

Phenology, growing degree days, growth and yield of wheat varieties

An experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during *rabi* season of 2014-2015 to find out the accumulated growing degree days (GDD) of the different varieties of wheat (BARI Gom 25, BARI Gom 26, BARI Gom 27 and BARI Gom 28) for different plant developmental events and to observe the dry matter production, growth and yield potentiality for the calibration of DSSAT crop modeling. The experiment was laidout in a RCB design with three replications. Seeds of all varieties were sown on 26 Novemver, 2014 in lines with maintaining 20 cm row to row spacing. Fertilizers were applied @ 120-30-90-15-3-1 kg ha^{-1} of NPKSZnB. Harvesting of different varieties was done from 09 March to 15 March, 2015. At the time of harvest, yield contributing characters were recorded from linearly collected ten plants and yield data were recorded by harvesting one square meter area. Yield and yield contributing characters were recorded and analyzed statistically using STAR statistical tool for agricultural research, developed by International Rice Research Institute (IRRI) and mean separations were done by LSD test. Among the varieties, BARI Gom 28 accumulated minimum GDD 1557.42 °C with minimum duration (103 days). Although BARI Gom 28 took the minimum duration to mature the highest seed yield (4046.34 kg ha^{-1}) was also recorded in BARI Gom 28 which was identical with BARI Gom 25 (3968 kg ha^{-1}) and BARI Gom 26 (3987 kg ha^{-1}). The lowest seed yield was obtained from BARI Gom 27, yielded 3542 kg ha^{-1}. From the above findings, it can be concluded that BARI Gom 28 produced maximum dry matter (14638 kg dm ha^{-1}) and seed yield (4046 kg ha^{-1}) with minimum duration (103 days) and GDD (1557.42°C). Since this variety is short duration, so that it could be fit very well in existing cropping pattern.

Coastal area

Effect of post-flowering salinity and water stress on dry matter production and yield of soybean

The experiment was conducted in a vinyl house of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during *rabi* season of 2015 to find out the most sensitive post-flowering growth stage of soybean and to assess the extent of yield reduction caused by salinity (100 mM NaCl) and water stresses (70% depletion of available water) at different post flowering stages. The treatments were; Control (T_1), Salt stress with irrigated 100 mM NaCl at 4^{th} to 6^{th} weeks after emergence (T_2), Water shortage (irrigated with 70% depletion of available soil water when wilting sign developed) at 4^{th} to 6^{th} weeks after emergence (T_3). Salt stress with irrigated 100 mM NaCl at 6^{th} to 8^{th} weeks after emergence (T_4), Water shortage at 6^{th} to 8^{th} weeks after emergence (T_5). Salt stress with irrigated 100 mM NaCl at 8^{th} to 10^{th} weeks after emergence (T_6), Water shortage at 8^{th} to 10^{th} weeks after emergence (T_7). Salt stress with irrigated 100 mM NaCl at 10^{th} to 12^{th} weeks after emergence (T_8), Water shortage at 10^{th} to 12^{th} weeks after emergence (T_9).

Shoot dry weight under salt (7.36 g plant^{-1}) and water stress (7.24 g plant^{-1}) was identical but significantly differed from control (11.98 g plant^{-1}) at 6^{th} to 8^{th} weeks after emergence. Similar result was also observed at 8^{th} to 10^{th} weeks after emergence. Significantly the lowest shoot dry weight (12.06 g plant-^{1}) recorded from water stress when treatment imposed at 10^{th} to 12^{th} weeks after emergence. Root dry weight slightly decreased under salt and water stress at all post flowering growth stages. Among the stresses, root dry weight decreased more in salt stress than water stress at 4^{th} to 6^{th} weeks, 6^{th} to 8^{th} weeks and 8^{th} to 10^{th} weeks after emergence. But at 10^{th} to 12^{th} weeks after emergence, root dry weight decreased more in water stress (2.62 g plant^{-1}) than salt stress (3.01g plant^{-1}). Shoot dry weight was found more sensitive to salt and water stress than root dry weight at all post flowering growth stages. The highest relative shoot dry weight (91.47%) was recorded from salt stress and the highest relative root dry weight (95.58%) recorded from water stress at 4^{th} to 6^{th} weeks after emergence. The highest seed yield of 10.47 g plant^{-1} was obtained from control followed by seed yield under salt stress at 10^{th} to 12^{th} weeks after emergence (8.68 g plant^{-1}). The lowest seed yield of 0.69 g plant^{-1} was obtained from salt stress imposed at 4^{th} to 6^{th} weeks after emergence. It might be due to salt residual effect that prevailing in the soil from flowering to maturity. The reduction in seed yield of soybean plants subjected to salt stress at 4^{th} to 6^{th} weeks after emergence may be due to an increased uptake of toxic sodium that accumulated in cells and become toxic to the plant. Among the stages, 4^{th} to 6^{th} weeks after emergence of soybean was found the most sensitive to salt in relation to seed yield reduction (93.41%). The salt stress imposed at 6^{th} to 8^{th} weeks after emergence also alarming for seed yield reduction.

Effect of time of sowing on plant stands growth and yield of cowpea in coastal area

An experiment was conducted at MLT site Kuakata, Patuakhali in the *rabi* season of 2014-2015 to verify the effect of sowing times in Cowpea in saline area of Patuakhali under farmers field condition. Three treatments: 17 December, 24 December and 31 December 2014. Yield and yield contributing characters were significantly differed among the three sowing time. The highest plant population (15.33/m^2) was found in the second sowing time (24 December) followed by 17 December (14.66 plant population/m^2) and the lowest recorded in third (31 December) sowing. The tallest plant (67.86 cm) was obtained from first sowing and plant height decreased gradually with the advances of sowing time. The highest number of branches (3.96) was observed in the last sowing whereas the lowest (3.2) was in second sowing. The highest number of pod (6.26) was found in first sowing followed by second (5.96) and third sowing (5.36). The longest pod (14.2 cm) was recorded in 17 December sowing and the shortest (10.36 cm) in third sowing. The maximum number of pod (14.23) was obtained from 17

December sowing and the lowest (11.66) was in 31 December sowing. The heaviest seed weight (85.33 g) was found in first sowing followed by second sowing (84 g) and the lightest 1000 seed weight (81.66 g) was observed in the third sowing. The maximum seed yield (1.06t/ha) was recorded from the first sowing i.e. 17 December 2014 followed by second sowing (0.945 t/ha) & the lowest (0.738 t/ha) from the late sowing may be due higher soil salinity. From two years results it might be concluded that mid December would be the optimum sowing time for cowpea cultivation in the coastal areas of Bangladesh.

Intercropping of mungbean with chilli at different planting system for coastal area

An experiment was conducted at FSRD site Razakhali, Patuakhali in the *rabi* season of 2014-2015 to verify the performance of intercropping of chilli and mungbean at different planting system under farmers field condition. Five treatments were as follows: T_1: 100% chilli, T_2: 100% Mungbean, T_3: One row chilli with one row mungbean, T_4: Two row chilli with one row mungbean, T_5: Two row chilli with two row mungbean. The highest mungbean equivalent Yield (3012 kg/ha) was obtained from the combination of intercrop treatment T_4 (Two row chilli with one row Mungbean). The highest gross margin (Tk. 66536) was obtained from treatment T_1 (sole chilli) followed by treatment T_4 (Two row chilli with one row mungbean) gave gross margin of Tk. 56744/ha. The lowest gross margin of Tk. 12841/ha was obtained from T_2 treatment (sole mungbean). Considering the equivalent yield and return, it revealed that two row chilli with one row mungbean was the most profitable as compared to other treatment combination of intercropping system. For more conformation the experiment needs to be repetitive in the next year.

Drought

Screening of grasspea genotypes against drought

A field experiment of grasspea genotypes against drought stress was conducted at the research field of Agronomy Division, BARI, Joydebpur, Gazipur during the period from November 2013-14 and 2014 to March 2015 to select drought tolerant grass pea genotypes. Thirty three (33) grass pea genotypes viz. BD 5253, BD 5260, BD 5261, BD 5262, BD 5263, BD 5264, BD 5265, BD 5267, BD 5268, BD 5269, BD 5270, BD 5271, BD 5272, BD 5273, BD 5274, BD 5275, BD 5276, BD 5278, BD 5279, BD 5280, BD 5281, BD 5282, BD 5284, BD 5285, BD 5286, BD 5288, BD 5291, BD 5313, BD 5317, BD 5316, BARI Kheshari 1, BARI Kheshari 2 and BARI Kheshari 3 were evaluated in this study. The experiments were laid out in factorial randomized complete block design with three replications. The seeds were sown on 30 November, 2013 and 16 November, 2014 maintaining row to row distance at 30 cm with continuous sowing. Fertilizers @ 23-18-20 kg ha^{-1} NPK were applied in the form of Urea, Triple super phosphate (TSP) and Muriate of potash (MoP) respectively. All fertilizers were applied at the time of final land preparation. A light irrigation was given after sowing of seeds for uniform germination both for control and drought condition. The control plots were irrigated four times at 25, 40, 55 and 70 days after sowing (DAS). Drought stress influenced phonological characters, yield contributing characters and yield. Among the genotypes BARI Kheshari 3, BD 5275, BD 5262, BD 5272, BD 5282, BD 5317, BARI Kheshari 2 and BD 5276 performed better under irrigated as well as drought condition. The seed yield reduced in all the genotypes under drought stress condition 22.95-35.76% in 2013-14 and 17.84-31.22% in 2014-15. In both the years (2013-14 and 2014-15 respectively) the highest seed yield 2248 kg ha^{-1} and 2231 kg ha^{-1} under irrigated/ control condition was produced by genotype BARI Kheshari 3 which was statistically similar with genotypes BD 5275 (2234 kg ha^{-1} and 2209 kg ha^{-1}), BD 5262 (2115 kg ha^{-1} and 2161 kg ha^{-1}) followed by genotypes BD 5272 (2033 kg ha^{-1} and 2094 kg ha^{-1}), BD 5282 (1944 kg^{-1} and 2065 kg ha^{-1}), BD 5317 (1942 kg ha^{-1} and 1991 kg ha^{-1}), BARI Kheshari 2 (1916 kg ha^{-1} and 1986 kg ha^{-1}) and BD 5276 (1904 kg ha^{-1} and 1981 kg ha^{-1}) and the lowest seed yield was obtained from genotype BD 5269 (1296 kg ha^{-1} and 1290 kg ha^{-1}). Genotypes BARI Kheshari 3, BD 5275, BD 5262, BD 5272, BD 5282, BD 5317, BARI Kheshari 2 and BD 5276 were selected on the basis of stress tolerance index (STI >0.8) because they produced higher grain yield both in irrigated and drought stress condition in both the year (2013-14 and 2014-15 respectively).

Charland

Performance of lentil varieties in char land area

An experiment was conducted at the char land of Jamuna river under Bhuapur Upazilla, Tangail (AEZ-8) during the *rabi* season 2014-2015 to find out suitable lentil varieties for char land area of Tangail and to increase production. Four modern lentil varieties viz. BARI Masur 3, BARI Masur 4, BARI Masur 5 and BARI Masur 6 were tested against a local check. The experiment was laid out in RCB design in three farmers' field considering as three replications. The unit plot size was 8m × 5m. The plots were fertilized with 21-36-25-10 and 0.4 kg ha^{-1} N P K S and B respectively. All the fertilizer was 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 seeds were sown on 11-16 November 2014 maintaining 30 cm line to line distance with seed rate of 35 kg ha^{-1}. Two weeding were done at 25 and 45 DAS. Other necessary managements were done as and when necessary. The crop was harvested on 04-09 March 2015. All BARI released lentil varieties proved superior over local one. Among these varieties, BARI Masur 6 produced the highest seed yield of 1.73 t ha^{-1} (92.22% higher yield over local variety) followed by BARI Masur 5 (1.46 t ha^{-1}, 62.22% higher yield over local variety), BARI Masur 3 (1.21 t ha^{-1}, 34.44% higher yield over local variety) and BARI Masur 4 (1.05 t ha^{-1}, 16.67% higher yield over local variety). The results revealed that BARI Masur 6 and BARI Masur 5 would be suitable for cultivation in charland of Jamuna river under Bhuapur, Tangail (AEZ-8) district for getting higher yield.

Performance of different french bean varieties in charland area

An experiment was conducted at the char land of Bhuapur,Tangail during the *rabi* season of 2014-15 to evaluate the performance of three french bean varieties (BARI Jharsheem 1, BARI Jharsheem 2, BARI Jharsheem 3). The experiment was laid out in a randomized complete block design with 3 replications. Seeds were sown on 23-25 November, 2014 with 30 cm × 15 cm spacing. The unit plot size was 8m × 5m. Each unit plot was uniformly fertilized during final land preparation @ 150, 100, 110, 40, 4 kg ha^{-1} N, P, K, S and Zn, respectively (Based on FRG 2012). The total amount TSP, gypsum, zinc sulphate and 50% of urea were mixed with the soil during final land preparation and the rest urea was top dressed 35 days after sowing (DAS). Irrigation and weeding were done as and when necessary. The crop was harvested during 28 January, 2015 to 12 February, 2015. Yield and yield attributes of bush bean varieties significantly differed in charland. The highest pod yield (17.63 t ha^{-1}) was obtained from BARI Jharsheem 3. The second highest pod yield (16.94 t ha^{-1}) was obtained from BARI Jharsheem 1, while the lowest from BARI Jharsheem 2. The results revealed that BARI Jharsheem 3 would be suitable for cultivation at charlad of Bhuapur, Tangail.

Performance of garlic varieties at different sowing date in char area of northern region

An experiment was conducted at char area, Mornea, Gangachara, Rangpur under RARS, Burirhat, Rangpur during *rabi* season 2012-13 and 2013-14 to observe the performance of different variety of garlic in different dates of sowing and to get maximum yield of garlic at farmers char areas of northern region. The experiment was carried out in split plot design with three replications. Five sowing dates in main plot viz. S_1:30 October, S_2:15 November, S_3:30 November, S_4:15 December and S_5:30

December and three varieties in sub plot viz. V_1: BARI Roshun 1; V_2: BARI Roshun 2 and V_3: local were accommodated in the experiment. The fertilizers were applied at the rate of 120-60-160-40-4 kg/ha N P K S and Zn in the format urea, TSP, MoP, Gypsum, and Zinc sulphate. Size of the plots was 4m x 3m and plant spacing was 20cm × 10cm in 1st year. In 2nd year plot size was 3m x 2m and plant spacing was same. The highest (5.53 t/ha) yield was observed from BARI Roshun 1 which was statistically similar with local variety and lowest (4.76 t/ha) from BARI Roshun 2 in 1st year while in 2nd year BARI Roshun 1 produced significantly the highest yield (5.20 t/ha) than BARI Roshun 2 and local. In both the year, with the delay in sowing dates from October 30 yield was reduced. The highest (6.80 and 6.39 respectively 2012-13 and 2013-14) bulb yield was recorded when sowing was done on October 30. The lowest (3.22 t/ha in 2012-13 and 2.99 t/ha in 2013-14) yield was obtained from 30 December sowing was 30 October is the best planting time for all the garlic varieties in 1st and 2nd year. Early planting up to 15 November with BARI Roshun 1 may also be considered for better yield of garlic in char area of northern region. From the two year results it may be concluded that BARI Roshun -1 was higher yielder than BARI Roshun 2 and local. 30 October would be the best sowing date for all the garlic varieties with the flexibility for BARI Roshun 1 up to 15 November in char area of northern region.

Fertilizer management of hybrid maize at char land eco-system

The experiment was conducted at char area, Mornea, Gongachara, Rangpur under RARS, BARI, Burirhat, Rangpur during *rabi* season at 2012-13 and 2013-14. Four fertilizer managements T_1: Recommended dose (250-55-110-40-4-2 kg/ha NPKSZnB), T_2: AEZ based (196-36-75-30-2-1 kg/ha NPKSZnB), T_3: Soil test based (189-30-79-46-1.5 kg/ha NPKSZn in 2012-13 and 188-45-107-27-4-1 kg/ha NPKSZnB in 2013-14) T_4: Farmer's practicing dose(171-23-56-10-8-3 kg/ha NPKSZnB) were tested in RCB design with 3 replications. Before conducting the experiment, the initial soil samples were collected from the experimental field and chemically analyzed in the SRDI laboratory. The spacing maintained for Maize was 60 cm × 20 cm. The size of the unit plot was 4m × 3m. Seeds of BARI Hybrid maize 9 were sown on 6 December, 2012 and 13 December, 2013. Maize was harvested at 15 May on 2013 and 28 May on 2014. Number of seeds/cob, 1000 seed weight and yield were significantly influenced by the fertilizer treatments in both the year. The highest number of seeds/cob (485.67 in 2012-13 and 568.20 in 2013-14) and 1000 seed wt. (348.70g in 1st year and 463.67 in 2nd year) were counted from the T_1 (Recommended dose) treatment which was statistically at par with the treatment T_3 (Soil test based). Significantly the highest yield (9.25 t/ha in 2012-13 and 9.81 t/ha in 2013-14) was obtained from T_1 treatment that was statistically identical to T_3 treatment. The lowest yield (6.12 t/ha in 1st year and 6.79 t/ha in 2nd year) was observed in T_4 (Farmer's practicing dose) treatment. From the two years result revealed that the recommended fertilizer dose performed better yield of maze which was statistically similar with soil test based fertilizer dose system but the highest economic performance was observed in soil test based fertilizer management. The highest Gross return (Tk 111000/ha and Tk 117720/ha in 2012-13 and 2013-14 respectively) obtained from recommended fertilizer dose (T_1) but highest gross margin (Tk 50168/h in 2012-13 and Tk 57728/ha in 2013-14) along with the highest BCR (1.89 in 1st year and 2.02 in 2nd year) was found in soil test based fertilizer management (T_1).

Adaptation of BARI released crop varieties in charland

The adaptive trial was conducted at two locations of charland of Pandma and Jamuna during 2014-2015. The adaptive trial was conducted at two locations of charland during 2014-2015. One location was at the charland of Koikunda, Lokhikunda union of Ishurdi, Pabna and another location was at Pina (Near Kashinathpur) of Bera upazilla of Pabna. Four mustard varieties like BARI Sarisha 11, BARI Sarisha 14 and BARI Sarisha 15 and BARI Sarisha 16 and three wheat varieties viz. BARI Gom 26, BARI Gom 27 and BARI Gom 28 were grown among the selected farmer fields of Koikunda. BARI Motorshuti 2 was broadcast on 11 November 2014 after recession of flood water. BARI Masur 6 and BARI Masur 7 were sown at Koikunda. All the mustard and lentil varieties were sown on 12-13 November 2014 at Koikunda. Wheat varieties were sown on 18 November 2014. At Pina three varieties of wheat (BARI Gom 26, BARI Gom 27 and BARI Gom 28) were sown on 20 November 2014. Lentil and pea were sown in residual soil moisture but other crops were grown in irrigated condition. Two irrigations were applied (25 and 55 DAS) in wheat and two irrigations were applied in mustard (20 and 40 DAE). Fertilizers were applied as per recommendation for the crops. All fertilizers were applied as basal. Only half N was top dressed in wheat and mustard just after first irrigation

Among the four mustard varieties, BARI Sarisha 11 produced the highest seed yield (1778 kg/ha) followed by BARI Sarisha 16 (1575 kg/ha) and other two varieties gave lower yield (1290-1474 kg/ha). BARI Masur 6 and BARI Masur 7 produced substantial seed yield with 1807 kg/ha and 1950 kg/ha respectively. Grain yield of wheat was 3337 kg/ha, 3450 kg/ha and 3618 kg/ha, respectively in BARI Gom 26, BARI Gom 27 and BARI Gom 28 varieties at charland of Padma. Seed yield of pea (BARI Motorshuti 2) was 1489. The grain yield was produced 2538 kg/ha, 3662 kg/ha and 2708 kg/ha respectively in BARI Gom 26, BARI Gom 27 and BARI Gom 28 at the charland of Pina. The BARI Gom 27 and BARI Gom 28 showed higher yield as compared to BARI Gom 26.

Hilly Area

Intercropping lalshak with chilli under different planting system

An intercropping experiment was conducted at Hill Agricultural Research Station, Khagrachari during *rabi* season of 2014-15 to find out suitable planting system of chilli and red amaranthas intercrop in hilly areas, to increase total productivity and economic return through suitable combination. Six intercropping combinations viz., T_1=100%Chilli (50 cm×40 cm) + 100% lalshak (broadcast), T_2= 100% Chilli (50 cm × 40 cm) + 75% lalshak (broadcast), T_3=100% Chilli (50 cm × 40 cm) + 50% lalshak (broadcast), T_4=100% Chilli (50 cm × 40 cm) + 25% lalshak (broadcast), T_5=Sole Chilli (50 cm × 40 cm)), T_6= Sole lalshak (broadcast) were evaluated. Local chilli & BARI Lalshak 1 were used as materials in this intercropping experiment. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 4m × 4m. Seedlings of chili were sown on 20 November & red amaranth on 27 November. In case of sole red amaranth the other sowing dates were 27 November, 7 January & 15 February. Sole chilli and intercropping treatments were fertilized with 120-80-120-20-4 kg/ha N P K S Zn B & for sole red amaranth with 40-10-30 kg/ha NPK. For sole chilli and intercrop the full amount of P K S Zn B and $^1/_2$ N were applied as basal in the form of triple super phosphate, muriate of potash, gypsum, zinc sulphate, boric acid and urea, respectively. The remaining N was top dressed at 25, 50 & 70 days after planting (DAP). For sole red amaranth $^1/_2$ N & all other fertilizers were applied as basal. Rest N was applied at 25 DAE. Irrigation was given after planting for proper establishment of crops. Irrigations were applied at 15 days interval. Three hand weeding were done at 20, 40 and 60 DAP to keep the crops reasonably weed free for chilli. The medium chilli yield (3.96 t/ha) and highest red amaranth yield (4.96/ha) were found in 100% Chilli (50 cm×40 cm) + 100% lalshak (broadcast) i.e from T_1. The highest gross income (TK 218000 /ha), net income (Tk.158000/ha) and benefit cost ratio (2.63) were recorded in the same combination. The results revealed that 100% Chilli (50 cm × 40 cm) + 100% lalshak (broadcast) combination might be suitable and economically profitable for the hill valley of Khagrachari.

11 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 hill irrigation development.

Effect of deficit irrigation to wheat on raised bed

The experiment was conducted during rabi season of 2014-15 at the research field of the Regional Agricultural Research station, BARI, Ishwardi, Pabna to find out the water requirements of wheat on raised bed and to relate soil moisture content behavior with the changing climatic parameters. This study consisted of following irrigation treatments, T_1= Three irrigations at (17-21) DAS, (55-60) DAS and (75-80) DAS, T_2= Irrigation at 30% soil moisture depletion (SMD), T_3= Irrigation at 50% soil moisture depletion (SMD), T_4= Irrigation at 60% soil moisture depletion (SMD) and laid out in a RCBD design with four replications. The result showed a significant effect of irrigation treatments on plant height, plant per m^2, and grain per spike, 1000 grain weight and grain yield. The highest grain yield (3.82 t/ha) was obtained from treatment irrigated at 17-21 55-60 and 75-80 DAS over the treatments at 30%, 50% and 60% SMD level so there used 307mm, 236mm, 220 mm and 250 mm of seasonal water, respectively. The second highest yield (3.55 t/ha) was obtained at 30% SMD level and closest to T_1. At water stress condition, wheat may also be cultivated on raised bed system with 2 irrigations (at 48 and 83 DAS) sacrificing minimum grain yield.

Wheat may be cultivated on raised bed system with 3 irrigations (at 26, 65, 80 DAS) for higher yield. Wheat may be also cultivated on raised bed system with 2 irrigations (at 48 and 83 DAS) sacrificing minimum grain yield. This technology saves 26.9% of irrigation water compared to conventional method. As, it is first year study, final conclusion can be drawn after further trial.

Effect of irrigation and mulch on the yield of maize in coastal areas

This study was conducted at the farmer's field located at Chandpasa union close to Babugong Upazilla of Barisal District to determine the experimental evidence of the effect of irrigation management and straw mulch on the yield of maize. The experiment consisted of two factors: irrigation and mulch. The irrigation and mulch treatments were: Main plot: Irrigation (4): I_1: Farmer practice, I_2: One irrigation at 4 leaf stage, I_3: Two irrigations at 4 leaf stage and 8-10 leaf stage, I_4: Three irrigations at 4 leaf stage, 8-10 and leaf stage and tasseling stage, Subplot: Mulch (4), M_1:(No mulch), M_2: 1cm mulch, M_3: 2cm mulch, M_4: 3cm mulch. The variety of test crop was BARI hybrid Maize-9. The treatment I3 produced the highest grain yield of 6.68 t/ha and I1 (farmer practice) produced the lowest yield of 6.00 t/ha. The treatment M_3 produced the highest grain yield of 6.47 t/ha and M_1 (no mulch) produced the lowest yield of 6.19 t/ha. The highest grain yield of 7.45 t/ha was obtained for I_3M_3 and the lowest of 4.79 t/ha was obtained for I_4M_4. The highest water use efficiency for grain production, WUE (37.44 kg ha/cm), was obtained at I_1 and the lowest (13.94 kg/ha/cm) was obtained at I_4. The highest water use efficiency for grain production, WUE (35.76 kg/ha/cm), was obtained at M_4 and the lowest (29.43 kg/ ha/cm) was obtained at M_1. The highest BCR (1.44) was obtained from I_3M_3.

Apparently from one year study, the highest grain yield of maize (7.4 t/ha) was found for two irrigations (each at 4 leaf stage and 8-10 leaf stage) having straw mulch thickness of 2 cm. The lowest yield (4.79 t/ha) was found from three irrigations (each at 4 leaf stage, 8-10 leaf stage and tasseling stage) with 3.0 cm mulch. The harvest index was found the highest for two irrigations each at 4 leaf stage and 8-10 leaf stage with 3.0 cm mulch. As this is one year study, definite conclusion can be made after further trial.

Effect of irrigation levels on seed quality and yield of maize

The experiment was conducted at the experimental field of IWM Division, BARI, Gazipur during 2012-2013, 2013-2014 and 2014-2015 and during 2013-2014 to 2014-2015 at RARS, Ishurdi to investigate the response of irrigation to seed quality and seed production of hybrid maize. Parental lines of BARI Hybrid Maize-9 (BIL79 x BIL28) were sown in isolation (time) maintaining ratio of four female rows alternate with two male rows (4:2). Male rows were sown in two different dates for synchronization. Four levels of irrigation were selected for the experiment. The irrigation levels were T_1: Two irrigations each at the vegetative (50-60 DAS) and grain filling (110-120 DAS) stages, T_2: Two irrigations each at silking (80-90 DAS) and grain filling (110-120 DAS) stages, T_3: Three irrigations each at vegetative, silking, and grain filling stages, and T_4: Four irrigations each at pre-vegetative (20-25 DAS), vegetative, silking, and grain filling stages. The results showed that most of the yield contributing parameters were found higher in treatment T_4. The treatment T_4 gave the highest seed yield both male (8.21 t/ha) and female (4.17 t/ha) at Joydebpur and (8.163 t/ha) and (5.87 t/ha) at Ishurdi, respectively. Vegetative stage was the critical stage to irrigation. Better seed quality was found in treatment T_4 with four irrigations in terms of germination percentage and seeding vigour.

From three years observation, it was found that for seed production, BARI Hybrid maize-9 had a good response to different irrigation regimes. The variety along with four irrigations each at pre-vegetative, vegetative, silking, and grain filling stages were found to produce better yield than that of other options. It can be concluded that vegetative stage was the critical stage for irrigation of BARI Hybrid maize-9. BARI Hybrid maize-9 was found to produce better quality seed in terms of seed germination and seedling vigour with four irrigations at different growth stages. Financial feasibility of that variety along with four irrigations was found better than other treatments.

Estimation of crop co-efficient values of sunflower by lysimeter study

The experiment was conducted on sunflower (Variety: BARI Surjomukhi-2) during the month of mid-November to mid-March in a lysimeter (dimension: 1m×1m×1m size) to measure the daily evapotranspiration of the crop (ETc) and crop coefficient (Kc) value from 2014 to 2015 at Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur. The study was conducted using four different treatments: T_1 = Irrigation at 10 days interval allowing drainage, T_2 = Irrigation at 15 days interval allowing drainage, T_3 = Irrigation at 20 days interval allowing drainage, T_4 = Irrigation at 25 days interval allowing drainage. Irrigation at 15 days interval produced highest yield and was considered suitable for estimating ETc and Kc. Seasonal highest ETc was found at 265.01mm.The kc values of sunflower at initial, development, mid-season and late season were found to be 0.70, 1.49, 1.95, and 0.50. These values were found higher than the values recommended by FAO. ETo was estimated by CROPWAT using climate data and location information. The variatious might be due to location, climate and environmental factors.

It was found from the study that crop coefficient values of BARI Surjumukhi-2 was 0.70, 1.49, 1.95, and 0.50 at the initial, development, mid-season, and late season stages of sunflower in semi-arid climate of Gazipur. The estimated values of crop coefficients for sunflower vary considerably at all the stages from those recommended by FAO. The variations were due to location and environmental effects on crop growth and yield. However, the estimated location specific crop coefficient values are prefered to use in irrigation planing and estimation of crop water requirements.

Effect of deficit irrigation on the growth and yield of sunflower

This experiment was conducted at the research field of Irrigation and Water Management Division, BARI, Gazipur, and Agricultural Research Station, Benarpota, Satkhira during the rabi season of 2013-2014 and 2014-2015 with BARI Surjomukhi-2. There were nine irrigation treatments, each replicated thrice in a randomized complete block design with additional spare plot. The treatments were: T_1 = FI at vegetative, pre-flowering, and heading stage, T_2 = $DI_{80\%}$ up to FC at vegetative, pre-flowering, and heading stage, T_3 = $DI_{60\%}$ up to FC at vegetative, pre-flowering, and heading stage, T_4 = FI at vegetative, and pre-flowering stage, T_5 = $DI_{80\%}$ up to FC at vegetative, and pre-flowering stage, T_6 = $DI_{60\%}$up to FC at vegetative, and pre-flowering stage, T_7 = FI at vegetative, and heading stage, T_8 = $DI_{80\%}$ up to FC at vegetative, and heading stage, and T_9 = $DI_{60\%}$ up to FC at vegetative, and heading stage. Furrow irrigation method was used. It was found that deficit irrigation (DI) was reduced plant growth such as plant height, leaf no./plant, root length density, canopy coverage, biomass and grain yield compared to full irrigation. About50 and 30% water was saved to produce 2.18 and 2.52tha-1 yield by applying DI60% up to FC at vegetative and pre-flowering stage in Gazipur and Satkhira which had increased water productivity (WP) and profit Each irrigation was done to replenish the depleted soil moisture from field capacity depleted. It was also observed that pre-flowering stage was the critical stage to deficit irrigation. From this study, it can be recommended that cultivation of BARI Surjomukhi-2 is suitable in saline and non-saline regions in terms of yield and oil content at DI60% at vegetative and pre-flowering stage compared to full irrigation (FI).

From the two years field observation, it was found that DI had significant negative effect on growth and yield of BARI Surjomukhi-2 at Gazipur and Satkhira. The plant height, leaf no./plant, root length density, canopy coverage and biomass were found to decrease by the application of DI compared to FI. But the yield was not reduced so much. The average yield of 2.18 and 2.52 t/ha was found at DI60% at vegetative and head formation stages in Gazipur and Satkhira by saving about 50% and 30% of water compared to those of FI. Consequently, the highest water productivity was found inDI60% at vegetative and head formation stages compared to full irrigation. Also net return was found the highest in DI60% at vegetative and head formation stages. The BCR of 2.80 and 4.21 were observed at Gazipur and Satkhira, respectively. It was also found that pre-flowering stage was the critical stage to deficit irrigation. It can be recommended that sunflower (BARI Surjomukhi-2) can tolerate water deficit without hampering significant yield and oil content in both saline and non-saline region. The farmers of salinity regions will get more net return in compared to that of Gazipur. So, this crop is also more suitable for salinity region.

Effect of irrigation on the yield and quality of litchi

An experiment was conducted at RARS, Hathazari, Chittagong and RARS, Ishwardi, Pabna during 2013-2014 and 2014-2015 to determine the effect of irrigation on yield and quality of litchi, as well as to identify the critical growth stages to irrigation. There were four irrigation treatments namely: T_1 = Farmers practice, T_2 = Irrigation at flowering stage, T_3 = Irrigation at fruit setting stage, T_4 = Irrigation at flowering and fruit setting stage. From the result it weas found that in Hathazari, yield and yield contributing characters varied significantly among the treatments. The average litchi yield of two years ranged from 17.50 kg/plant to 45.40 kg/plant. The lowest average yield (17.50 kg/plant) was obtained from the T_1 (Non- irrigated tree) and the highest average yield 45.40 kg/plant) was found from T_4 (irrigated at flowering and fruit setting stages). The highest amount of irrigation water (290 mm) was used by the highest yielder T_4 at 2014-2015. This was 349mm in 2013-2014. The economic return/tree was also the highest (Tk. 3861) from the irrigated trees T_4 in 2014-2015. In Ishwardi, the average litchi yield of two years ranged from 28.49 kg/plant to 52.77 kg/plant. The lowest average yield (28.49

kg/plant) was obtained from T_1 (Non- irrigated tree) and the highest average yield (52.77 kg/plant) was found from T_4 (irrigated at flowering and fruit setting stages). The highest amount of irrigation water (267 mm) was used by the highest yielder treatment T_4 in 2014-2015 and it was 349mm in 2013-2014.The economic return/tree was also the highest (Tk. 11607) from the irrigated trees (T4) in 2014-2015.

Irrigation had a significant effect on yield and quality of litchi in both Chittagong and Ishurdi regions. The flowering and fruit setting stages are the most critical to irrigation. Results show that rainfall had also significant effect on yield during fruit setting stage. The trends of results are similar in both the years. Cultivation of litchi is more profitable with at least two irrigations each at flowering and fruit setting stages in the studied regions.

Performance study of alternate wetting and drying furrow irrigation for tomato cultivation

A field experiment was conducted at BARI, Gazipur during the rabi seasons of 2013-2014 and 2014-2015 to assess a new irrigation method of alternate wetting and drying furrow irrigation (AWDFI) for tomato cultivation. The experiment was laid out in Randomized Block Design (RBD) with six treatments replicated thrice. Irrigation was applied by alternate wetting and drying furrow irrigation (AWDFI), fixed wetting and drying furrow irrigation (FWDFI), and traditional furrow irrigation (TFI). Each irrigation method was divided into two levels of irrigation to 100% field capacity (FC) and 80% FC at each application. The results of the study showed that dry matter of the tomato plant and marketable yield of tomato were not found to differ significantly between the treatments of AWDFI and TFI. However, there were better than FWDFI when irrigation water was applied at same irrigation levels. Marketable yield of tomato was similar between the treatments of AWDFI and TFI, when irrigated at 100% FC. AWDFI produced higher marketable yield by 7.86% than TFI when irrigated at 80% FC. Cull yield was higher by 15.79% and 5.9% in TFI than AWDFI system when irrigated 100% and 80% FC, respectively. The most important result was that AWDFI saved irrigation water by 37.8% and 35% (on average) compared to TFI without significant reduction in yields at the irrigation level of 100 % and 80% FC, respectively. Field water use efficiency was improved by 37% and 40% (on average) in AWDFI system compared to TFI when irrigation water was applied to 100% and 80% FC, respectively. The quality parameters (Total soluble solid and pulp) content of tomato fruits at harvest were found greater in AWDFI system than TFI at the same levels of irrigation. The benefit-cost ratio (BCR) and unit production cost (UPC) (Tk per kg of tomato) of the treatment AWDFI was attained similar to the treatment of TFI when irrigated with 100% FC. BCR was found greater and UPC was attained lower in AWDFI compared to TFI and FWDFI, respectively when irrigated with 80% FC., BCR was found higher in AWDFI by 2.8%, 8.6% and 11.4%, 10.2% (on average)than that of TFI and FWDFI when irrigated with 100% and 80% FC, respectively. AWDFI produced lower UPC(Tk per kg of tomato) compared to TFI and FWDFI by 2.8%, 8.9% and 23.3%, 12.8% when irrigated with 100% and 80% FC, respectively. However, AWDFI is a way to save water for tomato production. This new method may be feasible in drought prone areas where water and water supply methods are limited to irrigation for crop cultivation.

Based on two years' study, it may be concluded that plant growth, marketable yield, cull yield, water use efficiency and cost effectiveness of tomato production were found to have almost similar trend among the treatments. The new method of AWDFI can save a substantial amount of water. On an average, the water application method of AWDFI saved 38 % and 35 % seasonal water when irrigated to 100% and 80% field capacity, respectively, without significant reduction in yields. However, AWDFI has a great potential to adopt as water saving practice especially for drought prone as well as coastal areas where irrigation water is limited and scarce

Effect of alternate wetting and drying furrow irrigation the yield and water use efficiency of maize

Efficient irrigation method is now essential in the areas where water resources are limited for irrigation. Therefore, a new method of irrigation was used to investigate the effect of alternate furrow irrigation on crop performances, seasonal water use (SWU) and water use efficiency (WUE) of maize at IWM research field, BARI, Gazipur and ARS, BARI, Rajbari, Dinajpur. The field experiments were laid out in randomized complete block design in a spilt plot design with nine treatments replicated thrice. The treatments were accommodated by three irrigation levels (I_1, I_2 and I_3: Irrigation water applied to 100%, 80% and 60% field capacity, respectively) and three methods (M_1, M_2 and M_3:Alternate wetting and drying furrow irrigation(AWDFI), Fixed wetting and drying furrow irrigation (FWDFI) and Traditional furrow irrigation(TFI), respectively).Results showed that AWDFI could maintain approximately similar grain yield compared to TFI with almost 50% reduction in irrigation water when irrigated to 100% FC. The interactive effect of irrigation levels and methods had significant effect on crop growth rate (CGR) in the crop biomass and grain yield among the treatments while the same level of irrigation produced insignificant difference between the alternate furrow irrigation (M_1) and traditional furrow irrigation (M_3) methods. But significantly better CGR and grain yield compared to the fixed furrow irrigation (M_2) method were obtained. AWDFI and TFI produced around 7.8 and 7.9 t/ha in Gazipur and 9.5 and 9.9 t/ha in Dinajpur, respectively, when irrigation water was applied to 100% field capacity. AWDFI saved 39, 35 and 33% SWU at Gazipur and 27, 24 and 19 % SWU at Dinajpur compared to TFI when irrigation water was applied to 100, 80 and 60% FC, respectively. WUE was substantially improved by AWDFI. WUE was higher around 38, 34 and 31% in Gazipur and 23, 22 and 19% in Dinajpur in AWDFI system than TFI when irrigating with 100, 80 and 60 % FC. However, alternate wetting and drying furrow irrigation is an effective and water-saving irrigation technique which improves water use efficiency without insignificant yield reduction and may have the potential to be used in drought fields where maize production is heavily dependent on irrigation.

As this is one year study, it suggests that alternate wetting productivity and drying furrow irrigation (AWDFI) has the potential to improve both yield and water. AWDFI and traditional furrow irrigation (TFI) with irrigation to 100% field capacity produced maize yield around 7.8 and 7.9 t/ha in Gazipur and 9.5 and 9.9 t/ha in Dinajpur, respectively. Compared to the TFI, AWDFI technique saved seasonal irrigation water use by 27 % and 39 % and reduced total grain yield by around 4 and 1% when irrigated to 100% field capacity in Dinajpur and Gazipur, 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 production without significant yield attributes and yield reduction.

Development of nutrient and water management package for summer tomato cultivation under controlled environment

Fertigation has been found technically and economically feasible for tomato cultivation in winter as well as in summer season. Use of different levels of micronutrients has a significant effect on the yield and fruit quality of tomato and mulch can minimize the irrigation frequency due to soil moisture conservation. Considering this hypothesis, this experiment was undertaken with different levels of fertilizers under drip irrigation to develop a nutrient and water management package for summer tomato (BARI hybrid tomato-8) cultivation in silty clay loam soils of BARI, Gazipur. The study was conducted in consecutive there kharif II season of 2012, 2013 and 2014. Three levels of fertilizers, i.e. N_{100} P_{55} K_{120} $B_{1.0}$ $Zn_{4.0}$ $Mg_{4.0}$ kg/ha, N_{100} P_{70} $B_{2.0}$ $Zn_{6.0}$ $Mg_{8.0}$ kg/ha and N_{100} P_{55} K_{120} kg/ha (control) were considered under drip irrigation applied at 2 days interval. The treatments were arranged with mulch and without mulch. Rice straw was used as a mulching material. The treatment (T_4) consisting fertilizer doses of N_{100} P_{55} K_{120} $B_{1.0}$ $Zn_{4.0}$ $Mg_{4.0}$ kg/ha with straw mulch produced the highest marketable yield of summer tomato (40.98 t/ha, 33.02 t/ha and 33.46 t/ha) with minimum cull yield in all the years. The lowest yield (30.96 t/ha, 24.85 t/ha and 26.45 t/ha) was obtained from the treatment T_3 having no use of micronutrients and mulch. The mulched treatments received, respectively, 297, 289 and 310 mm of seasonal water ins 1st 2nd and 3rd years whereas the non-mulched treatments received 315 mm, 338 mm and 321 mm of seasonal water in the 1st, 2nd and 3rd year, respectively. The highest average BCR (3.71) was found in high yielding treatment in all the years along with average highest water productivity of 12.0 kg/m^3.

Lower doses of N and K along with micronutrients, B, Zn and Mg performed better in respect of fruit yield and fruit quality under drip irrigation at two days interval with straw mulch. So, the option with fertilizer dose N_{100} P_{55} K_{120} $B_{1.0}$ $Zn_{4.0}$, $Mg_{4.0}$ kg/ha with straw mulch under drip irrigation at 2 days interval can be considered to be an appropriate technology for summer tomato cultivation commercially. Large farmers and private entrepreneurs can adopt this technology for commercial cultivation. Summer tomato cultivation very much profitable to the farmers. Medium and large farmers can use this technology for summer tomato cultivation. It can help create employment opportunity for rural people during the lean period.

Performance of fertigation system on strawberry cultivation

Proper utilization and uniformity of water and fertilizer are usually considered to improve the water and fertilizer management systems. Therefore, this study was carried out to assess the fertigation system on the yields of advanced strawberry line FA-016 at the IWM Research Field, BARI, Joydebpur, Gazipur during the two rabi seasons of 2013-2014 and 2014-2015. Two drip irrigation levels i.e., drip irrigations at two and three days interval and three fertilizer doses $N_{110}K_{100}P_{40}S_{25}$kg/ha, $N_{75}K_{75}P_{40}S_{25}$ kg/ha and $N_{50}K_{50}P_{40}S_{25}$ kg/ha were tested. Soluble fertilizers like urea and muriate of potash were applied with water through drip system. Fertigation was done in four times at different growth stages of the crop. On average, growth parameters of strawberry were influenced insignificantly by different levels of irrigation and fertilizer application among the treatments. On average, the treatment T_2 (Drip irrigation at 2 days intervals with moderate fertilizer dose of N_{75}, P_{40}, K_{75}, and S_{25} kg/ha) produced the highest marketable fruits yield (11.53 t/ha) while the minimum marketable fruit yield (10.39 t/ha) was found in treatment T_6 where irrigation was applied at 3 days intervals with lowest fertilizer dose of N_{50}, P_{40}, K_{50}, and S_{25} kg/ha. The quality parameters (pH, total soluble solids, vitamin A and percentage of total sugar) were found almost similar among the treatments. The seasonal water use varied from 10.5-16.8cm throughout the growing period. The mean water productivity was varied from 7.62-8.51kg/m^3. On an average, the highest net margin (Tk. 17,98,102/ha) and benefit-cost ratio (6.01) was obtained from treatment T_2 where irrigation water was applied at 2 days intervals with moderate fertilizer dose of N_{75}, P_{40}, K_{75}, and S_{25} kg/ha. Proper amount of irrigation water with an optimum (N_{75}, P_{40}, K_{75}, and S_{25} kg/ha) fertilizer dose produced highest yield and consequently increased the net margin and benefit-cost ratio.

A positive impact of the effect of irrigation and fertilizer levels on the growth parameters and yield of strawberry was observed in this study. On an average, growth parameters of strawberry were not found significantly different among the treatments. The mean highest marketable yield (11.53 t/ha) was achieved when drip irrigation was applied at 2 days intervals with a moderate fertilizer dose (N_{75}, P_{45}, K_{75}, and S_{25} kg/ha).The yield of strawberry was the minimum (10.39 t/ha) when drip irrigation was applied at 3 day interval with the lowest level of fertilizer application (N_{50}, P_{40}, K_{50}, and S_{25} kg/ha). During the growing season, the seasonal water use varied from 10.5-16.8 cm. The maximum net margin and benefit-cost ratio were obtained from the treatment where irrigation water was applied at 2 days interval with moderate fertilizer dose. Based on the results of two year study, proper amount of irrigation water with an optimum fertilizer dose (N_{75}, P_{40}, K_{75}, and S_{25} kg/ha) was found to produce maximum yield and consequently increased the net margin and benefit-cost ratio. This technology can be disseminated among the large and commercial strawberry growers.

Growth, yield and water productivity of garlic under sprinkler irrigation

A field study was conducted in the experimental field of IWM Division, BARI, Gazipur during November to March of 2013–2014 and 2014–2015 to investigate the effect of different irrigation regimes on growth, bulb yield and water use pattern of garlic under sprinkler irrigation system. The water–yield relationship has been developed for garlic with different irrigation regimes under sprinkler irrigation to quantify crop water productivity functions (CWPF) for optimum use of irrigation water. Six irrigation regimes were: T_1 = Surface irrigation where crop was irrigated at 15 days interval; T_2 = Sprinkler irrigation at 40% of ETo; T_3 = Sprinkler irrigation at 60% of ETo; T_4 = Sprinkler irrigation at 80% of ETo; T_5 = Sprinkler irrigation at 100% of ETo; and T_6 = Sprinkler irrigation at 120% of ETo. Marginal water productivity (MWP) and elasticity of water productivity (EWP) were calculated using the relationship between bulb yield and seasonal evapotranspiration (SET). A continuous increasing trend in growth parameters and yield was recorded with the increase in SET to 100% ETo. However, with further increase in SET the same was decreased. In the first year, SET requirement was 254 mm for obtaining maximum yield of 9.10 t/ha, while in the following year, SET was 240 mm with maximum yield of 6.43 t/ha. But in both of the years, the highest water productivity was achieved with relatively low SET values. The highest water productivity (WP) of 3.76 kg/m^3 and 3.03 kg/m^3 was achieved with SET values of 211 mm and 191 mm, respectively, in the first and second year. In terms of bulb yield and WP, sprinkler irrigation found superior over the surface (conventional) one. Sprinkler irrigation with 100% ETo found most suitable for bulb yield of garlic. However, WP was found the highest in sprinkler irrigation with 80% ETo and after that declined with the increase in ETo. Hence, in water constraint situation, 80% ETo would be the most appropriate irrigation level for garlic production with sprinkler irrigation system. This study also confirmed that critical levels of SET needed to obtain maximum bulb yield or WP could be obtained more precisely from the knowledge of MWP and EWP.

The study outcome suggests that the sprinkler irrigation with different water regimes have significant effects on the growth and bulb yield of garlic. Irrigating at 60% ETo with sprinkler system can give identical yield as surface irrigation treatment, but saves about 48% of irrigation water. However, the 100% ETo produces highest bulb yield with slightly higher (about 6.5%) water consumption than that of the surface method. In general, higher water regime treatments had higher SET values. To achieve maximum WP, 230 mm of SET would require. On the other hand, to maximize yield SET would need to be 262 mm, which is about 14% greater than that of the water use at maximum WP. When CWPF was used, SET values ranged from 211 mm for maximum WP to 254 mm for maximum yield. Thus precise estimation of SET by using the concepts of marginal water productivity and elastic water productivity will be a useful tool for irrigated agriculture. Though the installation cost of a sprinkler system is higher than that of surface systems, farmers can receive higher yield with higher net return and BCR, if they maintain their sprinkler systems with proper scientific cautions.

Growth, yield and quality of mandarin and sweet orange as influenced by different method and levels of irrigation

The experiment was conducted at RARS, Akbarpur, Moulovibazar on existing orchard to investigate the growth, yield and quality of mandarin and sweet orange as influenced by different methods and levels of irrigation from December 2012 to April 2015. Kamala lines 26, 27 and BARI Malta-1 were used as the test crops.The experiment was conducted with 6 year (mandarin) and 4 year (sweet orange) old plantation. The four treatments were distributed in a randomized complete block design with four replications. The plant spacing was 4mx4m for mandarin 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 replenish the depleted soil moisture at the root zone to field capacity. In irrigated mandarin and sweet orange plants, growth was found more vigorous than non-irrigated plants. The result revealed that most of the parameters were higher in treatment T4 where drip irrigation was applied. The highest and the lowest yield of mandarin 1013 kg/ha and 406 kg/ha were obtained from treatments T_4 and T_1, and in sweet orange 7922 kg/ha and 1763 kg/ha were obtained from treatments T_4 and T_1, respectively. While, the highest yield was obtained from treatment T_4, total soluble solids (10.3and 7.7) and percentage of total sugar (4.53% and 4.21%) were the highest in treatment T3 for both mandarin and sweet orange. Drip irrigated treatments resulted in higher water productivity (3.08 kg/m3 for orange and 10.47 kg/m3for sweet orange) with minimum value in comparison to that with ring basin irrigation method (1.44 kg/m^3 for orange and 4.51kg/m^3 for sweet orange). Water productivity is higher in sweet orange than mandarin due to higher yield of sweet orange. The higher BCR was also observed in drip irrigated treatment (T_4).

This study showed that the mandarin and sweet orange performed well under drip irrigation system. Drip irrigation treatment resulted in higher IWP (3.04kg/m^3 and12.51 kg/m^3) with minimum value in comparison to that of ring basin irrigation (1.66kg/m^3 and 2.28 kg/m^3). The BCR was also higher in drip irrigation method. This is two years investigation. For fruit crops, this type of trial should be continued at least 3(three) crop cycles for recommendations.

Growth and yield of sweet orange as influenced by timing of fertilizer application and method of irrigation

This study was carried out at the experimental field of Irrigation and Water Management (IWM) Division, Bangladesh Agricultural Research Institute (BARI), 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. The treatments were: T_1 = Rainfed (normal practice), T_2 = Irrigation at 10 days interval by ring basin method (November-May) with recommended fertilizer applied two times in a year, T_3 = Irrigation at 15 days interval by ring basin method (November-May) with recommended fertilizer applied four times in a year, T4= 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 and total yield were found almost similar in 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 is performing better 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. This is an on-going study, and only the first year is completed. Definite conclusions may be drawn after the completion of the study cycle.

Fertilization at 2 (two) months interval with irrigation at 5 days interval (November-May) through drip system performed better in terms of plant growth and yield. The study is going on and most of the trees are bearing fruits for the second time. After 3-4 crop cycles, conclusions can be drawn that is transferable to the farmers and extention workers.

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 like Dhaka, Bogra and Dinajpur of Bangladesh. Primary and secondary data were collected through direct formal and non-formal field survey, monitoring and via questionnaire for farmers by researchers in 2015. Other information was gathered from national and international experiences, related past literatures in this field. All variable data were not available in this year (2015). The partial survey study indicated that the cost of irrigation water pumped using solar photovoltaic with accessories was between Tk 2,413,010 and Tk 3,500,000 with the panel capacity range from 4.2 kW to 8.4 kW, compared to Tk 25,000 – Tk 35000 with the capacity range between 2.98 kW and 4.48 kW by diesel powered pumping and Tk 120,000 – Tk 1,000,000 with the capacity range from 3.73 kW to 18.65 kW by pumping electric powered source. 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 crops production. However, this study will be continued in next year for detail analysis in achieving the objectives under various sources of irrigation pumps.

The initial cost of solar pump is very high right now; however, solar powered irrigation system has a good prospect and might be an alternative option for irrigation to different crops in Bangladesh. This system can minimize national consumtion of diesel and electricity power. At this stage, it is very difficult to make further comments as this is a partial one year study. This study will be continued in the next year for detail analysis in achieving a comparative senerio of solar, diesel and electric irrigation pumps.

Response of wheat to saline water irrigation in coastal areas

An experiment was conducted at the Agricultural Research Station, Benarpota, Shatkhira, Bangladesh Agricultural Research Institute during rabi season of 2013-2014 and 2014-2015 to investigate the response of wheat to supplemental irrigation with saline water in coastal areas of Bangladesh. Two different sources of saline water, viz., best available fresh groundwater (BAW) and canal water, were used for irrigating wheat. Three irrigations given at crown root initiation (CRI), booting, and grain filling stages with BAW (T_1, control); two irrigations given at CRI, and booting stages with BAW (T_2); one irrigation at CRI stage with BAW (T3); three irrigations at CRI and booting stage with BAW, and at grain filling stages with moderately saline canal water (T_4) were applied in the study. Wheat was irrigated with BAW and moderately saline canal water according to the treatments. Salinity of BAW (groundwater) over the years ranged from 2.8 to 4.3 dS/m while salinity of canal water ranged from 4.6 to 6.4 dS/m. Grain yield and yield contributing parameters like spike per square meter, number of grains per spike, and 1000-grain weight varied significantly with number and amount of irrigation water applied. But insignificant variation in yield and yield contributing parameters between treatment T_1 and T_4 was attributed due to the water quality not due to the number and amount of irrigation water. From two years average, the highest grain yield of 4.42 was obtained from treatment T_1 insignificantly followed by T_4 with the yield of 4.05 t/ha while the lowest (2.96 t/ha) was obtained from T_1 that received only one irrigation at CRI stage. Slight variation in grain yield between T_1 and T_4 implied that irrigation with saline canal water at the grain filling stage had little detrimental effects on the growth and yield attributing characters of wheat. Irrigation with saline ground water had almost no effect on increasing soil salinity; rather it helped to decrease soil salinity. On the other hand, canal water irrigation slightly increased soil salinity and consequently grain yield was slightly deceased. A significant difference in yield between two irrigation with BAW and three irrigations-two with BAW and one with canal water indicate that moisture that moisture stress was more harmful than salinity stress. Therefore, along with marginally saline ground water, moderately saline canal water can be used for supplemental irrigation to wheat where fresh water is limited.

Groundwater (Best available water) with a salinity of 2.8-4.3 dS/m is a good source to exploit for irrigation. However, available canal water with a salinity level of 4.6 to 6.4 can be applied for wheat irrigation in coastal areas where groundwater source is very much limited. As saline water irrigation increased the soil salinity level, long-term increase in soil salinity should be monitored. It is also necessary to look at whether monsoon rain is able to leach the accumulated salts to enable the soil ready for cultivating wheat for the next year. The study reveals that available canal water of moderate salinity can be an alternate source of irrigation to upland crops in coastal areas with sacrifising minimum yield loss.

Development of appropriate water management practices for increasing crop water productivity in saline area

A study was conducted during 2014-2015 at ARS, Benarpota, Satkhira with the two most common and intensive cropping patterns viz. Mustard (BARI Sharisa- 14) - Boro (BR Dhan-47) - T. Aman (BINA Dhan- 7) and Wheat (BARI Gom- 25) - Mung (BARI Mung- 6)-T. Aman (BINA Dhan- 7) of that area and compared to evaluate their comparative profitability in terms of yield and water use. Four different irrigation treatments were tried for different crops in a pattern. The treatments were: for wheat- Farmers' practice (T_1), irrigation at CRI (T_2), at CRI and maximum tillering (T_3) and at CRI, maximum tillering and flowering (T_4) stages; for mustard- Farmers' practice, irrigation at pre-flowering, at pod formation and at pre-flowering and pod formation stages; for mungbean- Farmers' practice, irrigation at vegetative, at flowering, and at vegetative and flowering stages; for T.Aamn- no irrigation, irrigation at booting, at grain filling, and at booting and grain filling stages; and for Boro rice- Farmers practice (ponding up to 3-5 cm), alternative wetting and drying (AWD) method with 20 cm(T_2), 30 cm (T_3) and 40 cm (T_4) depth. Rice equivalent yield (REY) varied with different irrigation treatments. In Mustard-Boro-T. Aman cropping pattern, rice equivalent yield was found the highest of 13.43 t/ha under T_2 irrigation regime. While the lowest REY of 12.86 t/ha was obtained in treatment T_4. On the other hand, in Wheat-Mung- T. Aman cropping pattern, the highest REY of 15.61 t/ha was obtained from T4 irrigation regime and the lowest was from Treatment T_2. Total water use and water productivity (WP) were found lower in non rice dominant pattern Wheat-Mung-T. Aman than rice dominant pattern Mustard-Boro-T. Aman pattern. Total water use varied from 1372 mm to 1720 mm with minimum in treatment T_4 and maximum in control treatment T_1 under Mustard-Boro-T. Aman pattern. In contrast, TWU was found the highest (1072 mm) in irrigation regime T_4 and the lowest was found in the most deficit treatment T_2 (836 mm) in Wheat-Mung-T. Aman pattern. In Mustard-Boro-T. Aman pattern, WP was ranged from 0.76 to 0.94 kg/m3 with the lowest in T1 and the highest in T4. While in Wheat-Mung- T. Aman pattern, WP ranged from 1.44 for T3 to 1.49 for T1 in kg/m3. Between the two patterns, the highest gross return (Tk. 93850/ha), gross margin (Tk. 48980/ha) and BCR (2.04) was realized by Wheat-Mung- T. Aman cropping sequence with T_4 water regime closely followed by treatment T_3. Though irrigation regime T_4 gave the best result in terms of yield and profitability, considering the water scarcity in saline areas the irrigation treatment T_3 can also be suggested for farmers.

In Mustard-Boro-T. Aman cropping pattern, REY was found highest (13.43 t/ha) under T_2 irrigation regime. On the other hand, in Wheat-Mung- T. Aman cropping pattern, the highest REY (15.61 t/ha) was obtained from T_4 irrigation regime. It indicated that non-rice crop has significant influence in increasing the REY. Though, in terms of yield and economic profitability, the non-rice crop dominant pattern with water regime of T_4 gave the best results, in the advent of water scarcity in saline areas the irrigation schedule under this pattern for treatment T_3 can be suggested for farmers.

Impact of irrigation water salinity on growth, yield and water use of wheat

Water and soil salinity are the factors determining crop growth and yield. A field experiment was conducted at the experimental field of IWM division of Bangladesh Agricultural Research Institute, Gazipur during December- March, 2013-2014 to investigate the effect of irrigation water salinity on the growth, yield components and yield of wheat. Irrigation with four fixed levels (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 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 level of salinity (13 dS/m). 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 4.33 and 5.14 t/ha were found in the control treatment and low salinity treatment in the first and second season, respectively, while the lowest yield of 2.83 and 3.58 t/ha was found in the high salinity treatment. On 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 level 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 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 season, 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 environment.

Irrigation with saline water has a detrimental effect on the growth and yield of wheat. Irrigation with saline water having salinity of 10 and 13 dS/m significantly suppressed most growth, yield and yield attributes of wheat compared to irrigation by fresh water as well as low saline water. Either irrigation by medium saline water throughout the growing season or irrigation by lower saline water at the early growth stages and higher saline 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. As irrigation with saline water increased the soil salinity, this should be taken into account whether there is a gradual increase in soil salinity for long term use of saline water for crop cultivation.

Field trial of screened advanced wheat genotypes/lines in saline soil

A field trial was conducted at the Agricultural Research Station, Benarpota, Satkhira of Bangladesh Agricultural Research Institute during rabi season of 2014-2015 to evaluate the performances of selected three wheat genotypes in saline soil at field condition in coastal areas of Bangladesh. The treatments of the experiment include: T_1 = BAW - 1147, T_2 = BAW - 1157 and T_3 = BARI Gom - 25. Medium saline canal water (4.6-6.8 dS/m) was used for irrigating crops. The highest grain yield (4.86 t/ha) was obtained from BAW- 1157 wheat genotypes comparing to other two genotypes BAW-1147 and BARI Gom-25. The soil salinity levels at different growth stages was found ranging from >2 dS/m to <11 dS/m. The genotype, BAW-1157 performed the best in terms of yield and water productivity under the saline condition.

The two promising wheat genotypes BAW-1147 and BAW-1157 performed well in field condition against different levels of soil salinity at different growth stages ranging from >2 dS/m to <11 dS/m. The genotype BAW-1157 performed the best under saline soil field conditions interms of grain yield and water productivity. This should be tested in saline soils of other saline areas during coming season.

Yield of watermelon as affected by different levels and methods of irrigation in coastal area

Efficient water management is necessary to sustain irrigated agriculture in areas with saline soil and water in Bangladesh. Therefore, a field experiment was carried out to investigate the effects of irrigation levels and methods on watermelon in saline soils of coastal area. The experiment was conducted in farmer's fields at Amtali, Barguna district during the rabi season of 2015. The field experiment was laid out in a randomized block design with four irrigation treatments of watermelon (Hybrid-Big family), replicated thrice. The treatments were as: T_1 = Farmer's practice (Four irrigations at different growth stages from initial vegetative to fruit setting with mulch), T_2 = Drip irrigation in raised bed at 3 days interval from initial vegetative to fruit setting with mulch, T_3 = Drip irrigation in raised bed at 5 days interval from initial vegetative to fruit setting with mulch, T_4 = Ring basin method at 15 days interval from emergence to fruit setting with mulch. Soil salinity (in situ electrical conductivity) increased from 5.8dS/m at the time of sowing to 9.6 dS/m at the time of harvest with farmer's practice irrigation management. Increasing irrigation frequency of watermelon from 22 to 15, 5 and 3 days intervals greatly reduced the build up in soil salinity during the second half of the season, and increased watermelon yield by more than 23 to 33%. The highest fruit yield of watermelon was around 40.3 and 35.2t/ha at 5 and 3 days irrigation intervals, respectively, while the farmer's practice (T_1) and ring basin method (T_4) produced the lower yield (34.8 and 27.1 t/ha) at 18 and 15 days irrigation intervals, respectively. The highest total water productivity of watermelon was 15.8kg/m^3 at 5ays d irrigation intervals (T_3) and lowest (8.2and 8.8 kg/m3) at 15 and 18 days intervals, respectively. The results show that high yields of watermelon (40.3 t/ha) can be achieved on moderately saline soils of the coastal zone with drip irrigation at 5 days intervals with mulch (T_3).

Increasing of irrigation number from four to twelve had effect on the development of soil salinity at initial and second-half of the growth stages. The results suggest that the yield response to increased irrigation number due to water availability at different crop growth stages. Increasing irrigation frequency of watermelon from 2 to 3 days intervals significantly reduced the build up of soil salinity during the second half of the season, and increased watermelon yield by more than 23 to 33%. The highest fruit yield of watermelon was around 40.3 t/ha at 5 days irrigation intervals with mulch (T_3), while the ring basin method (15 days intervals) produced the lowest yield (27.1 t/ha).The reduction in yield at lower irrigation frequency may have been due to higher salinity and water deficit. The one year results indicate that good yields of watermelon can be achieved on moderately saline soils of the coastal zone with the standard irrigation management with drip irrigation at 5days irrigation intervals with mulch which also gives high water productivity.

Comparative study on yield and water use by different cropping patterns in barind area

Experiments on rice based cropping systems for sustainable crop production were conducted at the Barind area of Rajshahi during 2013-15 in Randomized Complete Block Design with three replications. Four different cropping patterns with seven principal crops of that region viz: Musatrd-Boro-T. Aman, Wheat-Mung-T. Aman, Potato-Mung-T. Aman and Chickpea-Mung-T. Aman were compared to evaluate their comparative profitability in terms of yield, water use and economics. Three irrigation practices were tried for each crop in a pattern. The treatments were: for wheat- irrigation at CRI (T_1), at CRI and booting (T_3), and at CRI, booting and grain filling (T_3) stages; for mustard-irrigation at vegetative, at vegetative and flowering, and at vegetative, flowering and pod formation stages; for potato- at stolonization and tuberization (T_1), at stolonization and bulking (T_2), and at stolonization, tuberization and bulking stages (T_3), for mungbean- pre-sowing (PI), PI and at vegetative, and at PI, vegetative and flowering stages; for chickpea- no irrigation, irrigation at early vegetative, and at vegetative and flowering stages, for T. Aman- alternative wetting and drying (AWD) method with 20 cm (T_1), 25 cm (T_2) and 30 cm (T_3) depth; and for Boro rice- Farmers' practice (ponding up to 3-5 cm), (AWD) method with 20 cm (T_2), and 30 cm (T_3) depth. As yield of different crops in a particular cropping sequence varied, rice equivalent yield (REY) also varied with the different irrigation treatments. In all patterns, except Potato-Mung-T. Aman, rice equivalent yield was found the highest under T_2 irrigation regime. It ranged from 11.44 t/ha in Chickpea-Mung-T. Aman to 13.37 t/ha in Wheat-Mung-T. Aman cropping sequence. In Potato-Mung-T. Aman pattern, the highest REY of 29.48 t/ha was found in T_3 irrigation treatment. Though the trend of total water use was found higher in rice dominant patterns than non-rice dominant cropping patterns, the trend of water productivity (WP) was reverse.`In Mustard-Boro-T. Aman pattern, TWU varied from 1554 to 1977 mm whereas it varied from 890 to 927 mm in non-rice dominant patterns. WP ranged from 2.78 to 3.31 kg/m3 in Potato-Mung-T. Aman pattern, from 1.27 to 1.45 kg/m^3 in Wheat-Mung-T. Aman pattern and from 1.21 to 1.27 kg/m^3 in Chickpea-Mung-T. Aman cropping pattern. While it ranged from 0.61 to 0.75 kg/m3 for rice dominant Mustard-Boro-T. Aman cropping pattern. The relative degree of utilization of soil water storage was greatest in chickpea (83%), followed by wheat (67%), mustard (62%) and potato (61%). Among the patterns, on average over irrigation management, the highest gross margin and the BCR (Tk.309585/ha and 2.26) were obtained from Potato- Mung-T. Aman and the lowest values (Tk. 65755/ha and 1.52) were obtained from Mustard-Boro-T. Aman cropping sequence. Therefore, inclusion of non-rice rabi crops instead of boro rice can significantly reduce the irrigation requirements in dry season without having any adverse effect on farm's income.

Rice equivalent yield was found the highest under T_2 irrigation regime in all the patterns tested, except Potato-Mung-T. Aman pattern. It ranged from 11.44 t/ha in Chickpea-Mung-T. Aman to 13.37 t/ha in Wheat-Mung-T. Aman cropping sequence. In Potato-Mung-T. Aman pattern, the highest REY of 29.48 t/ha was found in T_3 irrigation regime. TWU found higher in rice dominant patterns and lower in non-rice dominant patterns. In case of WP, the trend was reverse.`In Mustard-Boro-T. Aman pattern, TWU varied from 1554 to 1977 mm whereas it varied from 890 to 927 mm in non-rice dominant patterns. WP ranged from 1.21 - 1.27 kg/m^3 in Chickpea-Mung-T. Aman pattern to 2.78 - 3.31 kg/m^3 in Potato-Mung-T. Aman cropping pattern. While it ranged from 0.61 to 0.75 kg/m3 for rice dominant Mustard-Boro-T. Aman cropping pattern. Among the patterns, the highest gross margin and the BCR (Tk.309585/ha and 2.26) were obtained from Potato- Mung-T. Aman and the lowest values (Tk. 65755/ha and 1.52) were obtained from Mustard-Boro-T. Aman cropping sequence. The yield of succeeding T. Aman crop was higher when pulse crop was introduced. Therefore, inclusion of non-rice rabi crops instead of boro rice and pulse as fallow crop can significantly reduce the irrigation requirements in dry season and increase the soil fertility without having any adverse effect on farm's income.

Sustainable crop production in drought and saline coastal areas of bangladesh under changing climate

This project (Funded by BCCTF) aims to develop a suitable irrigation water management practices based on the 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. In salt prone areas, both rice equivalent yield and water productivity were found higher in T_2 water management sequence, where modest amount of water was applied through irrigation. 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 and WP (54.60 t/ha and 5.73 kg/m^3) followed by Tomato-T.Aus-T. Aman (41.51 t/ha and 2.85 kg/m^3) and Watermelon-T.Aus-T. Aman (38.21 t/ha and 2.74 kg/m^3) cropping patterns obtained under 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 use pattern was Mustard-Boro-T. Aman with the 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) were obtained in Tomato-T.Aus-T. Aman. Total water use was also found higher in this pattern and ranged from 1437 mm to 1780 mm depending on irrigation management. In general, TWU was lower in non-rice dominant pattern than rice dominant pattern. REY and WP were 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 and the BCR (Tk. 649704/ha and 3.21) were obtained from Tomato- Jute-T. Aman under T_4 water management and the lowest values (Tk.

57604/ha and 1.44) were obtained from Wheat-Mung-T. Aman cropping sequence under T_2 water management in saline prone area. While in the drought prone area, the highest gross margin and the BCR (Tk. 751102/ha and 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) were obtained from Chickpea-Mung-T. Aman cropping sequence in T1 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.

In saline prone area, Tomato-Jute-T. Aman had the highest REY and WP (54.60 t/ha and 5.73 kg/m^3) followed by Tomato-T.Aus-T. Aman (41.51 t/ha and 2.85 kg/m3) and Watermelon-T.Aus-T. Aman (38.21 t/ha and 2.74 kg/m^3) cropping patterns under 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/m3) were obtained in Tomato-T.Aus-T. Aman followed by Potato-Maize-T. Aman (23.80 t/ha and 6.72 kg/m^3). Total water use was also found higher in this pattern and ranged from 1437 mm to 1780 mm depending on irrigation management. In general, TWU was lower in non-rice dominant pattern than rice dominant pattern. In both the areas, not a particular water management option was suitable for a particular crop and/or cropping sequences for getting higher profit. For example, the highest gross margin and the BCR (Tk. 649704/ha and 3.21) were obtained from Tomato- Jute-T. Aman under T_4 water management and the lowest values (Tk. 57604/ha and 1.44) were obtained from Wheat-Mung-T. Aman cropping sequence under T_2 water management in saline prone area. While in the drought prone area, the highest gross margin and the BCR (Tk. 751102/ha and 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) were obtained from Chickpea-Mung-T. Aman cropping sequence in T_1 water management.

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Adoption of power tiller operated seeder (PTOS) in rice-wheat cropping system

Power tiller operated seeder (PTOS) is called minimum tillage seeder and it is being used for different crops seeding along with seed bed preparation. It works as shallow tiling, 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 is demonstrated in different locations in the farmer’s field of Dinajpur, Thakurgaon, and Rajshahi area 2014-15. Recommended basal dose 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 planted after rice harvest and mungbean, sesame, jute planted after wheat harvest. The density of rice residue was 0.8-1.4 t/ha. PTOS 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. Movement of applied irrigation water was faster and less time required in minimum tillage than conventional method. Minimum tillage by PTOS saved irrigation water for wheat, maize and rice 14.9%, 5% and 30%, respectively compare to traditional irrigation method of crop cultivation. In dry surface condition of rice field no crack formation on the surface but in conventional puddling plots surfaced cracked. It is environment friendly, minimum disturbance soil and saved diesel fuel 94 l/ha/yr. Wheat yield was 25.5% higher than conventional method. Effective field capacity was 0.15 ha/hr. Cost of wheat seeding was Tk. 1950/ha which was 65.8% less than conventional method (Tk.5695.0/ha). PTOS covers about 4003 ha land in Rajshahi and Dinajpur area. Long term on station trial (6 years), wheat yield in minimum tillage by PTOS shows higher yield than conventional broadcasting system in rice-wheat-mungbean crop rotation maintaining 30% crop residue. No yield reduction trend observed over the time compare to conventional method. There are about 980 numbers of seeders now in the country which cover about 29000 ha land for different crpops.

Fine tuning of power tiller operated bed planter

A power tiller operated bed planter has been improved and fine-tuned with locally available materials in Regional Wheat Research Centre, BARI, Rajshahi and adaptive trials were conducted in the farmer’s field of Rajshahi and Dinajpur area 2014-15. 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 enhances adoption considering the added advantage of easy comfortable operation. The size of pulley was 8.5” (216 mm). Power transmission chain of the bed planter was divided into two parts avoiding shaking of chain during overcome land boundary (aiel). A Saifeng type bed planter also developed first time at BARI, Rajshahi. There was only Dongfeng type bed planter was available earlier. The bed planter formed a trapezoidal shape raised bed and can perform seeding and fertilizing operations on the top of the bed simultaneously in one operation. The bed planter is to be attached behind the power tiller (these are readily available in Bangladesh with reports of up to 700,000 within the 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 1.7 t/ha and 1.8 t/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 maize yield were 4.8 t/ha and 8.3 t/ha, respectively. The same wheat and maize yield in conventional method were 3.5 t/ha and 8.1 t/ha, respectively. Yield advantage was 33% over conventional method. Long term on station trial (6 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 returns for wheat cultivation in bed planting were 1.2 times than conventional system. The bed planter is now using as custom hire basis in the farmers field. There are about 6325 ha lands under bed planting system.

On farm validation of zero tillage planter for up land crops production

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. A low cost and robust power tiller driven (12 Hp) zero-till planter has been improved with inclined plate seed meter assembly in Regional Wheat Research Centre, BARI, Rajshahi Bangladesh with locally available materials for seeding different kinds of seeds. This is a pull type implement hitched with tiller at the drawbar point replacing the regular tilling part of it. The validation trials of zero-till planter with weed control management were conducted in the farmer’s field in Rajshahi areas for wheat, maize,,and pulses establishment during the year 2011-2014. The planter can pull 4 tynes in soft and medium hard soil but 3 tynes for hard soil. The planter was capable to apply seed and fertilizer in an opening slit of width 30mm and depth 60mm. 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 farmers saved plant establishment cost 50-65%, and minimizing the average turn around time 7-9 days between the two crops. The effective area coverage and planting cost by the seeder were 0.12 ha/h and Tk.1900.0/ha, respectively. Long term trial (6 years), zero tillage wheat yield shows continuously higher than conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% residue. No yield reduction trend observed over the time. Fertilizer management, weed control and selection of right crop variety with proper crop rotation are the key issue for adopting this new technology.

Performance evaluation of a tractor mounted vegetable transplanter

A tractor mounted vegetable transplanter performance was tested in experiment field of Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2014-15. It was used for transplanting seedling of tomato and cauliflower. The average field capacity of the machine was 0.091 ha/h. It has provision for arrangement of depth of placement for different seedling. The average depth of placement were found 4.15 and 2.95 cm for tomato and cauliflower respectively. The missing and damage rate was 3%. 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). There were no significant difference of yields of tomato and cauliflower among the treatments. This experiment will be continued to the next year for improvement of the transplanter for its better performance.

Enhancement of the productivity through mechanized intercropping system in wheat-maize-rice cropping pattern

The experiment was conducted at Regional Wheat Research Institute, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season 2014-15. The experiment was laid out in a RCBD with three replications. Treatments were viz. T_1=Wheat (sole) sowing manually in bed, T_2=Potato (sole) planting manually in bed, T_3=Wheat+Potato (inter crop) (sowing+planting) manually in bed, T_4=Wheat (sole) sowing mechanically in bed, T_5=Potato (sole) planting mechanically in bed, T_6=Wheat+Potato (inter crop) (sowing+planting) mechanically y in bed. Yield and yield contributing characters did not show any significance difference among the treatments wheat. On the other hand, in case of potato.

Evaluation and extension of power tiller 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 average 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 2014-15. Four speeds and three seed sizes were varied to evaluate the planter. Uniformity of spacing varied with the increase of operational speed. 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 Rajshahi. The average effective field capacity of cup type planters were 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. Labour requirement for whole tuber seed planting in case of planter and conventional method were 4 man days and 67 man days, respectively. 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.

Field performance evaluation of hand operated no-till seeder for crop establishment

No-till farming has many advantages in different ways. Less tillage of the soil reduces labor, fuel, irrigation and machinery costs. No-till can increase yield because of higher water infiltration and storage capacity, and less erosion. No-till farming can be more profitable if performed correctly with appropriate machinery. Li-seeder is a manual seeder for no-till planting developed by Conservation Tillage Research Centre, China. Two Li-seeders were collected from China Agricultural University, China in the year of 2013. To evaluate the field performance it was tested for maize (BHM-7) in research field of Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute (BARI) during April and May 2015. The performance of Li-seeder was found good and detailed study will be made in next year.

Design and development of dry land npk briquette applicator

A manually operated (urea, phosphorus, potassium) NPKbriquette applicator for upland crops was developed at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2013-14. The covering part of the applicator was modified to improved its performance during 2014-15. 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 10decimal/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 and applicator, which are very similar. It has good response to the NPK briquette application by machine or hand for long duration crops like as chilli, brinjal, tomato, etc. This experiment will be continued to the next year for improvement of the applicator for its better performance.

Development and performance evaluation of an axial flow pump

An axial flow pump of 150 mm diameter (6″) was designed, fabricated and tested at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2013-14. During 2014-15, 102 mm (4″) axial flow pump was designed, fabricated and tested. The pump was operated with 10.0 hp diesel engine. The highest discharge (17.34 L/s) was obtained at the head of 1.0 m and pump speed of 1500 rpm. The lowest discharge (8.53 L/s) was obtained at the head of 4.0 m and pump speed of 1474 rpm. The pump could not be operated above the head of 4.0 m. At 1.0 m water head, fuel consumption was 0.93 L/h and it increased linearly to 1.23 L/h at the water head of 4.0 m. Water horse power increased with the increase of water head up to 3.0 m and above this water head, water horse power declined. The axial flow pump may be adopted for low head (≤4.0 m) surface water lifting for irrigation and aquaculture.

Design and development of a power tiller operated multi-row weeder for wheat

A power tiller operated multi-row weeder was designed and fabricated at Farm Machinery and Postharvest Process Engineering Divisional workshop, BARI, Gazipur in 2012-13 for weeding of wheat. Improvement of the weeder is going on and three major modifications were done during 2014-15. Modification of shovel blades, addition of cutting disks and narrow size (65 mm) cage wheel impart some improvement in weeder maneuverability and performance. The weeder was compared with other available weeders namely BARI dryland weeder and hand spade for wheat to find its performance. The power tiller operated multi-row weeder obtained the higher field capacity (0.14 ha/h) was found. In spite of higher percentage plant damage (4.58%) shown by the power weeder but it has not significant effect on crop establishment. Whereas the cost of weeding was found the lowest (930 Tk/ha) compared to other weeding tools.

Comparative performance evaluation of different manual injector type usg applicators

Different type 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 2014-15. 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 1.07days respectively.. This experiment will be continued to the next year for its better performance.

Development of a power tiller operated potato harvester

A power tiller driven potato harvester has been developed with locally available materials in Regional Wheat Research Centre, BARI Rajshahi. It is a semi automatic digging machine. Potato harvester acts as digs the potato beds, high speed rotating flat conveyer belt carry loose soil with potatoes and its high speed rotation separate the potato tubers from soil. Finally pick up the exposed tubers from the soil surface by hand. The potato harvester consist of i) digging blade ii) conveyer flat chain iii) Guide plate iv) Power transmission arrangement. The dimension of the harvester is 900 x 850 mm x 950 mm. There are two model potato harvester, (i) Power take from fly wheel belt pulley to rotate the conveyor chain (ii) power take from gear box of power tiller and rotate the conveyor chain. It covers daily average 8 bighs land depend on operator skillness. Potato harvester requires labour 21 per ha only instead of 60 labours per ha in traditional manual method. Harvesting cost by potato harvester is Tk. 8,357 per ha but manually harvesting cost is Tk.17,100 per ha, respectively. Potato harvester saved 51% cost and 65% labour. Moreover, there are no potatoes remain inside the soil. Potato damage percentage is only 1.21%. Potato growers are always pass in risk of bad weather especially harvesting time. Sometime unpredictable rain causes huge damage. So, potato harvester can cover many areas within limited time and escape bad weather uncertainty and can reduce labour dependency.

Modification and performance evaluation of a mango harvester

Mango harvester is mainly used for harvesting mango fruits with less drudgery and preventing damage to the tree branches or fruits as compared to manual plucking and tree shaking. A mango harvester was designed and fabricated in Farm Machinery and Postharvest Process Engineering Divisional workshop, BARI, Gazipur during 2014-15 to reduce postharvest loss. The weight of modified harvester is 4.1 kg whereas existing harvester is 1.5 kg. The mango was harvested from different heighted mango trees in different location of BARI campus. The highest capacities of modified and existing harvester were found 76.15 and 72.48 kg/h. 95% of mangoes with pedicel length above1-1.5 cm were found by modified harvester whereas it was 82% for existing harvester. The modified BARI mango harvester observed to be heavy weight which reduced its capacity of harvesting but harvested fruits with long pedicel thereby increasing the shelf- life of the fruits. The experiment will be continued for improvement of harvester in the next year.

Development of a mechanical vegetable washing machine

A study was conducted in Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. A base line survey was conducted on vegetable production, sorting, washing, packaging mainly of carrot, red amaranth and brinjal from three vegetable growing districts such as Narsinghdi, Bogra, Jessore, and one major carrot growing area Pabna for developing a mechanical vegetable washing machine. Two upzila from each district were selected considering the primary and secondary markets. The respondents for primary data collection were 71 farmers, 30 pickers and 20 retailers. Washing of vegetables mainly practiced by farmers and pickers and it varied from location to location. Sorting and grading were done either farmers or pickers. In all locations, red amaranth and root crops (carrots and radish) are washed by farmers to get better price. A vegetable washing machine was designed based on the base line information. The capacity of the machine would be 1.0-1.5 ton/h depending on the type of vegetables. The fabrication is going on and expected to complete in the next financial year (2015-16).

Modification of a hot water treatment plant for fruits

Existing BARI hot water treatment plant for fruits was operated mainly by electric power ranged from 10 to 20 kW. Convey rollers and stirrer were rotated by a single phase electric motor and water was warmed by single phase electric immersion heaters. In rural areas, 10-20 kW 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 fabricated in the Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2015. An electric motor of 0.38 kW used for rotation of both the conveyor roller and stirrer. Two electric immersion heaters of 2 kW each used instead of 10 heaters of 2 kW capacity of existing one for instantly recover the heat that absorbed by the immersion treated fruits. The plant was made of stainless steel sheet (SS), SS roller, SS shaft, SS sprockets, chains and SS angle bar etc instead of MS materials of existing one. The chula was made of MS rod, MS angle bar and MS sheet for heating water initially using locally available biomass. A 15 kg of fire wood was required for heating of 400 litres water in the plant for treating fruits within 50 minutes. The capacity and price of the plant are 448 kg/h for mango and Tk 1,20,000 ($1600) respectively. Treatment cost by the plant is 0.68 Tk/kg.

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 Divisional workshop, BARI, Gazipur during 2014-15 so that both peeling and shelling can be done in the same machine. This machine has two parts in which peeling are 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 of the manual and power peelings were 83.63 and 330 kg/h respectively. The moisture content of the maize cobs with skin was 19% and without skin was 18.32%. The average engine and machine speed were 1247 and 360 rpm respectively. A little portion of maize cobs was shelled during peeling operation. This problem will be eliminated by reducing and adjusting gaps between the spiral and rubber rollers and peeling operation with different moisture content of maize cobs will be done in the next year.

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 2013-14. 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 ^{o}C. At heat pump outlet temperature of 40 ^{o}C, 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. The experiment will be continued next year for drying of different products along with quality analyses.

Development and performance evaluation of a mini oil expeller

An 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 2013-2014. Overall dimension of the expeller was 1640 ×560 ×985 mm and operated with 13.8 hp diesel engine. During 2014-15 an another smaller size mini oil expeller was designed and fabricated. Overall dimension of the expeller 840×797×815 mm and power required to operate the machine was 4.0 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%). Some minor faults were observed and this may eliminated by fine tuning. This machine will be tested for different types of oil seeds in the next year. Then the machine need to be demonstrated in the farmers field for its dissemination. Then the machine need to be demonstrated in the farmers field for its dissemination.

Design and development of an onion stem cutter

Onion is an important spices in Bangladesh. Bulb of onion is to trim from the stem. So, tops of onion are cut at 1.5-2 inches above the onion bulb. This operation is done manually in Bangladesh which is laborious, time consuming and costly. An onion stem cutter was designed and fabricated in Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2012-13. The stem cutter was made with locally available materials and operated it with a 0.37 kW electric motor. Important parts of the machine were feeding table, conveyor, cutter and outlet. The stem cutter was developed and tested during 2014-15. Capacity of the stem cutter was 75 and 50 kg/h for onion and dried garlic respectively.

Development and performance evaluation of a palm oil expeller

Bangladesh has to import 1.5 million metric tons of edible oil other than mustard seeds every year at a cost of more than $1.5 billion. Palm oil is low-cost edible oil. Currently, 1.2 million metric tons of crude palm oil is being imported and refined here a year. Its consumption is suitable for human health and its yield per hector is much higher than any other edible oil. There are some palm orchards available in different locations in Bangladesh. This research program has undertaken to develop small-scale palm oil extraction machine and palm oil refining procedure to utilize the available palm fruits in the country. The main aim of this study is to design and fabricate a palm oil expeller and evaluate its performance.

Enhancement of shelf-life of papaya through pre-treatments

Papaya is infected by postharvest disease caused by some fungi after harvesting. The quality and quantity losses of papaya occur due to disease attacks and lack of proper postharvest handling. Fungus can be destroyed or made inactive by chemical or heat treatment. Most of the chemicals are hazardous for human health. Heat treatment technology is simple and is a non-chemical method to kill or inactivate pest and to control fungus. The matured papayas were treated by hot water at different combination of exposure times and temperatures. Total weight loss of treated and untreated fruit increased with the storage period. The weight loss of treated fruits was higher than that of untreated fruits. The treatments exhibited significant variation in respect of total weight loss during ripening. In first and 2nd year study, significantly the highest shelf-life of papaya were found in treatment T_{12} (52 °C for 35 minutes with $CaCl_2$ solution) and T_{12} (50 °C for 35 minutes with $CaCl_2$ solution). In third year, the shelf-life of treated and untreated papaya was not found significant difference. Hue angle of treated and untreated papaya decreased with the increase of storage period. Higher values (ranged from 91 to 120˚) indicted that colour of peel surface of treated papaya was not good appearance for marketing. The disease incidence and severity of papaya treated and untreated fruits started from 4 to 5days after storage periods. In third year experiment, disease incident and severity of treated fruits were higher than untreated fruits. Hot water treatment could not able to reduce postharvest loss and extension of shelf-life of matured papaya.

Design and development of a coffee pulper

The most laborious part of the coffee processing is the pulping or removal of outer skin of the coffee cherry. The first step of coffee processing after harvesting beans and beans are taking out from ripen cherries. A drum type manual coffee pulper was developed in Farm Machinery and Postharvest

Process Engineering Division (FMPE) of Bangladesh Agricultural Research Institute, Gazipur during 2012-2013. The pulper was made of locally available materials. The clearance between the drums was 3-5 mm and it is adjustable with a knob so that it can pulp the coffee cherries of any size. The pulper was tested during 2014-2015 in the laboratory of FMPE Division, BARI, Gazipur and field test was done at Hill Agricultural Research Station, Khagrachari with the fresh and ripe coffee cherries. The capacity of the pulper was found 23.08 kg/h. The performance of the pulper was good. Separation of pulped beans from the skins has to done manually.

Design and development of a cashewnut sheller

The most laborious part of the cashew nut processing is the shelling or removal of outer shell of cashew nut. It also has some health implications due to the corrosive action of cashew nut shell liquid on human skin. A vertical disc type sheller was designed and its fabrication work is ongoing at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2013-2014 and the laboratory test was done in 2015. The sheller was made of locally available materials. The clearance between the disks is adjustable so that it can shell the cashew nut of any grade. The highest shelling efficiency was found for roasted cashew nut (45.5%). The whole kernel recovery percentage (7.5%) and shelling rate (120 no./hr) were found very poor. So the sheller should be modified or redesigned to improve its performance.

Development of solar dryer for drying of spices seeds

A solar dryer was designed, fabricated and installed at Spices Research Centre, Shibganj, Bogra for drying of spices seeds. As a spices chilli was dried following three different techniques named drying with solar collector, drying without solar collector and drying of partial shading of the collector. The open sun drying of chilli was done simultaneously to study performance among them. The germination percentage at dryer with collector was found 55% in the dryer whereas 76% at open sun with drying time of 3 and 8 days respectively. Again in case of chamber drying without collector the germination was found 75% in the dryer with drying time of 8 days and 73% in open sun with drying time of 9 days. The germination percentages of dryer with partial shade of solar collector and open sun was found 71% and 74% with 6 and 8 days of drying time. Though solar drying was quick way of drying of chilli than that of sun drying but the germination percentages of sun drying was found well than that of solar drying at every case.

Performance evaluation of lithium ion battery for operation of BARI developed small powered machinery

Solar powered technology is a promising technology, especially in the off-grid areas of Bangladesh. But, one of the main constraints of solar technology is that it cannot be operated during off sunshine period due to cloudy and foggy weather or at night time. This limitation may be overcome using lithium ion battery. BARI Solar Pump and BARI Winnower were operated and tested with lithium ion battery at Farm Machinery and Postharvest Process Engineering Division of BARI, Gazipur during 2014-2015. One horse power solar pump and half horse power Winnower were operated with five kilowatt lithium ion battery. The battery was charged by 900 W_p capacity solar panels. Total time required for full battery charging was 10 hours. Total discharging time of lithium ion battery for operation of solar pump and winnower were three hours 20 minutes and six hours, respectively. The average discharge of solar pump at the suction heads from 1.5 to 6.5 m was 187 L/min. During operation of winnower by lithium ion battery, the speed of motor as well as the machine remained almost constant although the voltage and current reduced sharply with the operation time. Therefore, BARI solar sump and BARI winnower operated by lithium ion battery were found to be technically suitable during off sunshine period.

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 RWRC, BARI Rajshahi 2015. 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 first time under this programme in Rajshahi.

Training and demonstration programme on BARI developed farm machinery

The list of trainings and field demonstrations on BARI developed farm machinery during 2014-2015 are given in Table 1. Fifty nine training batches were conducted by Farm Machinery and Postharvest Process Engineering Division, BARI, of which 1205 trainees were trained on BARI developed Farm Machinery. Various categories of participants such as Upazila Agricultural Officers, Scientific Officers Assistant Professors, Lecturers, Sub-assistant Agriculture Officers (SAAO), Mechanic, Scientific Assistant, Farm Machinery Manufacturers and farmers were trained. Farmers' trainings were conducted in the Farm Machinery Technology Development and Dissemination (FMTD) project sites. Others trainings were arranged at Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur. The training courses were on both theory and practical lessons on BARI developed farm machinery. Fifty seven trainings were conducted by the financial support of GoB through Farm Machinery Technology Development and Dissemination (FMTD) project. Other two trainings were sponsored by Bangladesh Agricultural Research Council (BARC) and organized by jointly Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur and Agricultural Engineering Unit of BARC.

13 AGRICULTURAL ECONOMICS

Import and Export Parity Analysis of Selected Vegetables and Spices in Bangladesh

The study was undertaken to find out the export potentialities of selected vegetables and import substitution of selected spices crops in Bangladesh. A total of 720 vegetables and 320 spices growers, 25 suppliers, and 25 exporters were randomly selected for the study. Net margin analysis was done on both variable and total cost basis. Domestic resource cost (DRC) analysis was also done for estimating comparative advantage of the selected vegetables and spices. The study revealed that net margins were positive for all vegetables and spices producers. However, the highest net margin was estimated for brinjal producers (Tk 273799/ha) followed by bitter gourd producers (Tk 152145/ha). In the case of spices, the highest net margin was received by ginger producers (Tk 231399/ha) followed by onion producers (Tk 122308/ha). Comparatively low net margins were found for okra (Tk 51830/ha) and garlic producers (Tk 99352/ha). Vegetables exporters received the highest net margin(Tk 32852/ton) from UK market which was higher than the Middle East market (Tk 22869/ton). The highest benefit cost ratio (BCR) was calculated for brinjal (1.9) followed by ash gourd (1.8). The estimated BCR were 2.1 and 1.8 for ginger and garlic respectively. Bangladesh had comparative advantage of producing all selected vegetables and spices as the estimates of domestic resource cost (DRC) were less than one. The values of DRC for all selected spices were less than unity implied that the production of these spices would be highly efficient for import substitution.

Expert Elicitation for Estimating Varietal Adoption of Lentil in Bangladesh

The study was undertaken to find out variety wise adoption rate of lentil in Bangladesh through expert elicitation procedure. Many varieties have been developed by BARI and BINA but in details of varietal information and adoption information database was not developed which is very important and valuable for the scientist and policy planner. This study through expert elicitation for constructing detail varietal development and adoption database is timely and necessary for the research institute. From all over the Bangladesh 12 experts was invited to share their valuable knowledge and experience on lentil cultivation and adoption in the country. The average age of the experts was 51 yrs and average experience on lentil adoption was 21 yrs. The lentil expert informed that 16 major varieties are adopted by the farmers in the recent year (2013-14). Among those varieties, BARI Masur-6 covered highest cultivated area (54,642 ha) which shared 30.04% of total lentil cultivated area. BARI Masur-4, BARI Masur-3 and BARI Masur-5 ranked 2nd, 3rd and 4th position according to the share of cultivated area covered. The seed production information showed that BADC the only lentil seed producer supplied 2151 mt of lentil seed in the year 2009-2013. The trend of seed production by different lentil variety revealed that over the period 2009-13, the seed production of BARI Masur-3 increased sharply but BARI Masur-4 gradually decreased. The adoption of variety BARI Masur-6 increased due to its high yield attribute. The another variety BARI Masur-4 and BARI Masur-3 adoption increased due to its high yield, resistant to rust disease attributes which showed increasing adoption path among the expert. Satisfying higher demand for lentil consumption and ensuring food security through providing alternative to winter crops are the major concerning issue of the policy planner and the scientist.

Expert Elicitation for Estimating Varietal Adoption of Maize in Bangladesh

The study was undertaken to find out adoption of maize in Bangladesh through expert elicitation procedure. Very valuable information about maize was collected through the elicitation of 14 experts who had expertise of different discipline of maize sector through involving in maize research and extension at different corners of the country. On an average, the expert's age was 47 years, and had 12 years of experience on maize research and extension. The seed releasing authority of Bangladesh released 86 varieties in the period 1986-2014. Among those varieties highest number of variety released in the period 2006-10 followed by 26 released variety in the period 2010-2014. Although all the varieties were released by the authority, but 21% of them are developed and released by the public research institute. Highest percentage of variety cultivated within the period 1986-2014 were hybrid which developed by nationally and imported by private organizations. The adoption information provided by experts revealed that 17 different varieties were cultivated on highest percentage of cultivation area. Among those cultivated varieties, Dekalb 981 covered highest percentage (13.78%) of cultivation area followed by Miracle (11.11%), NK 40 (9.03%) and Pioneer 30V92 (7.75%). The highest adopted variety Dekalb 981 covered 42167 ha of maize land which is followed by Miracle (33,997 ha), NK 40 (27632 ha), Pioneer 30V92 (23715 ha). Very recently the demand for Dekalb 981 maize increased due to its high yielding attribute. Another variety Dekalb 942 is getting popularity among the farmers due to its heat tolerant and lodging resistant attributes. The experts identified that the demand for NK 40 is decreasing due to its lower yield compare to newly introduced variety and susceptibility to leaf blight disease. The locally developed maize varieties can't keep their position in the varietal competition leaded by imported varieties. Variety developed by NARS with the support of CIMMYT has a small share in adoption status. This indicated that there is a very wide scope to give more emphasis on varietal improvement of maize by NARS.

Expert Elicitation for Estimating Varietal Adoption of Wheat in Bangladesh

The study was undertaken to find out variety wise adoption of wheat in Bangladesh through expert elicitation procedure. Many varieties have been developed by WRC but in details of varietal information and adoption information database was not developed which is very important and valuable for the scientists and policy planners. Expert elicitation for constructing detail varietal development and adoption database is timely and necessary for the research institute. A total of 14 experts were invited to share their valuable knowledge and experience on wheat cultivation and adoption in the country. The average age of the experts was 54 years and average experience on wheat was 23 years. The wheat experts informed that 13 major varieties are adopted by the farmers in the recent years (2013-14). Among those varieties, BARI Gom-24 (Prodip) covered highest cultivated area (186026 ha) which shared 41.03% of total wheat area. BARI Gom-21 (Shatabdi), BARI Gom-26 and BARI Gom-23 (Bijoy) ranked 2nd, 3rd and 4th according to the share of cultivated area covered. The seed production information showed that BADC the only wheat seed producer supplied 24913mt of wheat seed in the year 2013-14. The trend of seed production by different wheat variety revealed that over the period 2010-14, the seed production of BARI Gom-24 (Prodip) increased and BARI Gom-21 (Shatabdi) decreased. Increased seed production trend of Prodip variety leaded to highest adopted area of that variety. The main reason behind highest adopted area of Prodip variety was high yield, big spike, large grain and lodging tolerance character. Although the Prodip covered highest area but other newly developed varieties like BARI Gom-25, BARI Gom-26, BARI Gom-27 and BARI Gom-28 were the most promising varieties which showed increasing adoption path among the expert. These varieties have very good potentiality due to having short duration, tolerance to terminal heat stress, tolerant to salinity and lodging. Satisfying higher demand for wheat consumption and ensuring food security through providing alternative to rice are the major concerning issue of the policy planners and the scientists.

Assessment of BARI Mango Varieties in Comparison with Other Varieties

This study was undertaken to know the existing status of BARI released mango varieties in contrast with other varieties in the field level. Three large commercial firms having mother orchard mango trees, namely, Basherhat, Dinajpur (2066 mango trees); Chilahati, Nilphamari (7118) and Nayadingi, Manikganj (1341) were selected purposively. Thus, the study constitutes a total of 10525 mother mango trees. More than forty varieties were found in the surveyed commercial firms and among the ten BARI mango varieties, four varieties, namely, BARI Aam-1, BARI Aam-2, BARI Aam-3 and BARI Aam-4 were found there. Among all the varieties, BARI Aam-3 appeared to be the best in all the firms in terms of last four year sale of stions (stock+scion), of which amount of sale was much higher than that of other remaining varieties' accumulated sale. Hence, it is easily comprehended that BARI Aam-3 is likely to be the single most popular variety to be unparallel with any other variety. Apart from this variety, Kiozoi, Haribhanga, BARI Aam-4 and Mohachanak were identified as the most promising varieties. However, BARI Aam-3 is known as Amropali not as BARI Aam-3 in the field. People even do not know that this variety is a BARI released variety. Therefore, initiative should be taken to acquaint this excellent variety as BARI Aam-3 in the field.

Socioeconomic Impact of Wheat Seed Storage at household level in Bangladesh

Small and marginal farmers have little access to improved seed from institutional sources and are thus largely excluded from the benefits of new varieties. The production and storage of improved seeds at the household (HH) level can successfully overcome this problem. Therefore, an attempt was made to assess the impacts of wheat seed storage systems at HH level, with a particular emphasis on how the farmers are benefited by doing the seed storage business. The study analyzed data and information collected at random from 210 supported and 60 non-supported farmers spread over three wheat growing districts namely Mymensingh, Faridpur and Rangpur. The study revealed that wheat farmers used different storage containers and showed highest level of satisfaction towards plastic sac along with poly bags and plastic/metal drum due to cost effectiveness and better quality seed. On an average, supported and non-supported farmers retained respectively 103 kg and 100 kg of seed at household level for own use (79-85%), sale for higher price (63-65%), timely sowing (28-35%), and higher yield (27-37%). They sold most of their seeds to neighbouring farmers, local markets, and dealers. Wheat seed storage at household level was a profitable business to most of the respondent farmers. They could earn a reasonable net income (Tk.1127-Tk.1210) from seed storage. The farmers who stored seed in plastic/metal drum received the highest net income for higher storage capacity, less storage cost, and higher seed price. A substantial increase was recorded in wheat area, productivity, and financial benefit of the wheat farmers as a whole. Nevertheless, improved wheat seed is now available at farm level and most farmers become enthusiastic towards wheat cultivation because of this program. Respondent farmers did not face any critical problem during seed storage. The study strongly recommends that the existing training and dissemination program should be extended to other new and promising areas for fostering wheat cultivation as well as improving farmers' income in Bangladesh.

Financial Impact of Shifting of Land under Cereal Crops to Mango Cultivation in Selected Areas of Bangladesh

The study was conducted in three mango growing districts namely ChapaiNawabganj, Natore, and Rajshahi during 2014-2015 to estimate the financial benefit of shifting cereal lands to mango production, factors influencing shifting decision, and explore related problems of mango cultivation in the study areas. A total of 180 farmers taking 60 farmers from each district were selected randomly for the study. About 49% lands were shifted to mango cultivation from cereal crops which was higher in ChapaiNawabganj (55%) followed by Natore (48%) district. The main reason of this shifting was reported to be higher profit compared to other crops. The average total cost of mango cultivation was Tk. 133889 per hectare. Higher cost was observed in the 16th -20th year of garden (Tk. 152010) followed by 11th -15th year (Tk. 1,48952). The average yield of mango was found to be the highest in 16th – 20th year (26.48 t/ha) followed by 11-16th year (19.38 t/ha). Per hectare net return from mango cultivation was Tk. 175244. Total cost of mango cultivation was 10% higher than Boro-Fallow-T. Aman cultivation. On the other hand, total cost was about 40% lower than Wheat- Jute- T. Aman, Wheat-Aus-T. Aman and Potato-Fallow-T. Aman. The net return from mango cultivation was 75% higher than other cropping patterns. The shifting of cereal lands to mango cultivation was found to be a profitable enterprise since the BCR (2.89), net present value (Tk 337166) and internal rate of return (39%) was very high. Relative income, farm size and education turned out to be positively significant, whereas age was negatively significant for shifting decision from cereal crops to mango cultivation. Insects and diseases infestation, non-availability of quality insecticides, dominance of intermediaries, and lack of storage facilities were the major problems for mango cultivation.

Sunflower Cultivation in Selected Areas of Bangladesh: A Farm Level Study

The study was conducted in Bogra and Satkhira districts to assess the socioeconomic status of sunflower cultivation in Bangladesh. A total of 100 sunflower cultivating farmers, taking 50 farmers from each district, were randomly selected for this study. The highest 59% farmers cultivated sunflower because of its higher profitability than other crops. Per hectare cost of producing sunflower was estimated as Tk. 62,199. Per hectare net return and BCR were Tk. 15,282 and 1.25 respectively which indicated that sunflower cultivation was profitable. Stochastic frontier function revealed that the use of labour, seed, organic fertilizers, cost of irrigation, and land type had positive and significant effect on the yield of sunflower. Average technical efficiency of the farmers was 86% which implies that there is a scope of increasing productivity of sunflower by 14% using current level of inputs by increasing the farmers' efficiency. Lack of irrigation facility, scarcity of seed on time, absence of sunflower oil mill and sunflower market, low demand for sunflower, high cost of seed, etc. were the major problems of sunflower production and marketing. In spite of having some problems 18% female farmers became interested to cultivate and 56% farmers mentioned that their demand for edible oil is becoming fulfil. So there is great potentiality of sunflower cultivation in Bangladesh. The availability of sunflower seed with low cost and establishment of sunflower oil mill is needed to sustain this crop in Bangladesh.

Profitability and Technical Efficiency of Turmeric Farming: Evidence from Khagrachari District

The study estimated the profitability and technical efficiency of turmeric farming in Khagrachhari district. A total of 150 turmeric farms located in Khagrachari Sadar, Panchari and Matiranga Upazila of Khagrachari district were selected randomly for primary data collection. Data were collected, using a pre-tested questionnaire during January, 2015. The study revealed that turmeric farming is a profitable farming with some dominating variable costs like seed (rhizome) and sowing, harvesting and carrying. The net return was Tk. 112139 per hectare and the BCR was 2.20, indicates that turmeric farms have greater benefits than costs as well as positive net benefits. Seed (rhizome) and fertilizer showed significant positive effects on the turmeric production in the stochastic frontier production model. Turmeric farming displayed much variability in technical efficiency ranging from 44.2 to 95.2% with mean technical efficiency of 82%, which suggested a substantial 18% of potential output of turmeric can be recovered by removing inefficiency. Besides improving technical efficiency, potential also exists for raising turmeric production through higher education and extension services. For a land scarce country like Bangladesh this gain could help increase income and ensure better livelihood for the hilly farmers. The key policy implication of the analysis is that investment in education and extension service would greatly improve technical efficiency.

Impact of Farm Mechanization on Potato Production and Labour Use Pattern in Some Selected Areas of Bangladesh

The study was conducted in three districts namely Rajshahi, Dinajpur and Rangpur of Bangladesh during 2014-2015 to find out the effect of mechanization on productivity and labour use in potato cultivation. A total of 130 samples taking 75 from conventional and 55 from mechanized potato farms were selected randomly for the study. The findings revealed that the yield of potato under mechanized farms (22.60 t/ha) was higher than that of conventional farms (20.53 t/ha). Total cost of production was significantly higher for conventional farms. Gross margin was found to be higher for mechanized farms (Tk.129937) compared to conventional farms (Tk. 138777). Cowdung, TSP and MoP had significant positive effect on the yield of potato production under mechanized farms. On the other hand, human labour and irrigation had significant positive effect on the yield of potato production for conventional farms. Mechanized farm used less number of labours compared to conventional farm. Family labour was mostly affected by the mechanization. Animal power and output have positive effect on labour requirement, while power tiller and input costs have adverse effect on labour requirement for potato cultivation. The probability of adopting farm mechanization was significantly influenced by experience, education, farm size, training on potato cultivation, organizational participation and extension contact. Lack of technical knowledge for all machines operation was mentioned as a major problem of mechanization in the study areas.

Production and Export Opportunities of Jara and Colombo Lemon from Bangladesh

The study was conducted in two districts namely Sylhet and Narsingdi to know the production technology of Jara and Colombo lemon growers, estimate profitability and identify the constraints of Jara and Colombo lemon cultivation. A total of 120 farmers taking 60 for Jara lemon from Sylhet and 60 for Colombo lemon from Narsingdi were selected randomly for the study. Data were collected through a pre-tested schedule during April-May, 2015. Cost return analysis revealed that Jara and Colombo lemon cultivation were profitable in the study areas. Among different years, per hectare highest cost was incurred Tk. 413575 in the (11-15)th year garden and lowest cost was Tk. 365777 in 2nd year garden in Jara lemon cultivation. Gross return was highest in 5th year garden (Tk. 1995750/ha) and lowest Tk. 975600/ha in (11-15) th year garden. The benefit cost ratio at 6.5% rate of interest was 2.85and IRR 98%. Colombo lemon cultivation highest cost was estimated Tk. 316505/ha in 4th year garden and lowest cost was Tk.257543/ha in (11-15) th year garden. Gross return was highest Tk.841522 in 5th year garden and lowest Tk. 413616/ha in (11-15) th year garden. The benefit cost ratio at 6.5% rate of interest was 1.81and IRR 124%. Lack of improved production technology, poor quality saplings, insect/pest infestation, adulteration of fertilizer and insecticides and less number of export buyers were found major constraints both Jara and Colombo lemon.

Constraints and Opportunities of Cut-Flower Production and Export from Bangladesh

Bangladesh has immense prospect for exporting cut-flowers to the world market. Although the share of export earning in cut-flowers increasing day by day, export is constrained some barrier. Thus the present study was undertaken in Jessore (Jhikargachha) and Dhaka (Savar) to examine the financial profitability, value addition and constraint of cut-flower production, marketing and export in Bangladesh. A total of 170 respondents consisting 120 producers, 48 traders and 2 exporters were selected for the study. Multi-stage simple random sampling technique was followed and both primary and secondary data were used. The per hectare total cost, net return and BCR were Tk. 687439, Tk.261509 and 1.38 for gladiolus cultivation. The BCR, NPV and IRR of rose cultivation were 1.46, Tk. 2325762 and 146% which indicated highly profitable to the farmers. Farmer-cum-wholesaler, local traders, local wholesaler, wholesaler Dhaka, retailer Dhaka, other district retailer and exporter were the main actors of cut-flower marketing and export. In rose marketing highest value addition (Tk.185/100 pieces) was observed for retailer Dhaka and lowest value addition (Tk.70/100 pieces) was observed for local traders (faria) in Jessore. In gladiolus marketing highest value addition (Tk.302/100 stick) was also observed for retailer Dhaka and lowest value addition (Tk.88/100 stick) was observed for local traders (faria) in Jessore. The growth rate of export earnings from cut-flower during 2008-09 to 2013-14 was 14.4 which indicate export earnings increased by 14.4% per annum.The exporting cost of rose in Japan markets was Tk.407/kg or Tk.13.56/piece and net value addition was Tk.556/kg or Tk.18.53/piece. Despite such potentialities, cut-flower export was constrained by high airfreight charge, insufficient cargo place, absence of refrigerated transportation, lack of improved packaging materials, lack of quality flower as international standards etc.

Adoption and Relative Profitability of BARI Chinabadam-8 and Dhaka-1 in Jamalpur and Sherpur District

The study was designed to assess the technological adoption and comparative profitability of BARI Chinabadam-8 and Dhaka-1 cultivation at farm level in selected areas of Jamalpur and Sherpur districts. A total of 120 farmers, 60 for BARI Chinabadam-8 and 60 for Dhaka-1 growers were selected for this study. Descriptive statistics with Cobb-Douglas production function model was applied for analyzing the primary data. The findings of the study revealed that BARI Chinabadam-8 and Dhaka-1cultivation was highly profitable in which BARI Chinabadam-8 was more profitable than Dhaka-1 variety. The study indicated that per hectare gross return was significantly influenced by the use of human labour, seed, insecticide and irrigation. These factors were responsible for influencing gross return of both BARI Chinabadam-8 and Dhaka-1. Nevertheless, farmers were facing some problems and constraints in cultivating the groundnut in char areas of Jamalpur and Sherpur districts. These problems included lack of quality seeds, irrigation facilities and shortage of financial capital.

Maize Supply and Demand Situations in Bangladesh: Policy Implications

Maize is introduced as a relatively new crop in the rice based cropping patterns of Bangladesh. But now maize is an important cash crop to the farmers. Beside this it contributes a larger share of poultry and fish feed mills as raw materials. Information regarding actual demand and supply situations of maize in Bangladesh is absent. No one can say about this. For this the present study was undertaken to quantify maize demand and supply along with its constraints towards strengthening maize subsector. Both primary and secondary data and information were used in this study. Secondary data were collected from BBS, DAE and research reports. The total area under maize cultivation is estimated to be 0.3 million hectors producing 2.2 million MT with an average yield of 7.0 t/ha during 2013. But in 1996-97 the yield of maize was only 2.48 ton/ha. Current maize yield in Bangladesh is unpleasant. Potential maize yield is assumed as 12.61 ton/ha where yield of winter and summer maize in 2013-14 is 7.14 and 5.98 ton/ha respectively.A large part ofmaize demand in poultry and fish feed mills are fulfilled through import especially from India.During the period July, 14- April, 15 total no. of L/C opened for maize import was 124 of which settled was 173 for importing 113683.5 ton maize.Storing cost of maize is Tk 14/ kg per year. Nationally 60% of imported maize are using for broiler feed production and the rest are using for fish feed production.

Assessment of Production and Marketing of Latiraj (BARI Panikachu-1) in Jessore Region

The study assessed the profitability of latiraj (BARI panikachu-1) production and marketing in Jessore region. Data were collected from 60 randomly selected panikachu farmers in Jessore district and 45 traders where 30 from Jessoremsrket and 15 from Dhaka market. The total quantity of fertilizer require was 2974 kg/ha of which urea, TSP, MoP, zipsum and boron were 1011 kg/ha, 1076 kg/ha, 629 kg/ha, 230 kg/ha and 28 kg/ha respectively. Total labor requirement was 910 man days per hectare. Other input material was land preparation cost was 7145 Tk./ha, seedling 37895 no./ha, manure 10000 kg/ha, insecticide cost 13044 Tk./ha and irrigation cost incur 25989 Tk./ha. Total cost of production of panikachu was 358966 Tk./ha where as 337966 Tk./ha was variable cost and fixed cost was Tk. 21000/ hectare. Among the cost item labor cost is the high as 50.69% and fertilizer cost incurs

17.43% cost of production. The yield of rhizome and stolon were 50 ton and 35 ton per hectare. The average gross return was calculated as Tk. 655000 per hectare. The net margin of panikachu cultivation was 296034 Tk./ha. On the average, benefit cost ratio was found to be 1.82 on full cost basis and 1.94 on cash cost basis. All the co-efficient of human labor, seedling, urea, TSP and MoP were positive and significant effect on panikachu production. Manure, boron and zipsum application had negative but significant impact on the yield of stolon.Marketing cost of Faria, Bepari, Paikar and Retailer were 55.70 Tk./quintal, 239.46 Tk./quintal, 34.73 Tk./quintal and 201.86 Tk./quintal respectively. Net margin of different actors like Faria, Bepari, Paikar and Retailer were Tk. 279.30 /quintal, Tk.525.54 /quintal, Tk.165.27 /quintal and Tk.448.14 /quintal respectively. Insect infestation mainly prodonia caterpillar and foot rot disease were the main problem in the panikachu cultivation. About 95% farmer faced insect and disease problem at latiraj field. High price of input material was another problem faced by the farmer. The farmer had no marketing problem in the study area due to high demand of stolon.

Marketing and Value Chain Analysis of Ginger: A Study in Selected Areas of Bangladesh

The study was undertaken to determine marketing system, marketing cost, margin, efficiencies and to examine the value chain of ginger aiming to determine the value addition in different steps of ginger marketing. Primary data were collected from Nilphamari and Lalmonirhat depending upon the concentration of production and commercially marketing of ginger and consuming area Dhaka and Rajshahi. Data were analyzed using marketing margin, profit and efficiency ratio, and value addition. Four major marketing channels were identified for domestic produced ginger marketing. Channel-3 was the most important supply chain through which 48% domestic produced ginger reaches to consumers. Marketing costs for each 100 kg of ginger were estimated from Tk. 86.92 to 339.77 and marketing margin Tk. 674.00 to 1820.00, respectively for different intermediaries. Marketing margin and profit were the highest in retailer than those of other intermediaries. Out of four marketing channel, Channel-4 was more efficient than those of other channels. Six actors like; farmer, local trader, beparies, commission agent, wholesaler, retailer and consumer are identified who are involved in the ginger value chain. The study revealed that farmer added the highest amount of value Tk. 2062.00 per 100 kg ginger followed by retailers (Tk. 1820.00), Beparies(Tk. 835.00), local trader (Tk. 690.00) and wholesalers (Tk. 674.00) respectively. Eleven marketing problem were identified, among them price fluctuation, high transport cost and lack of loan facilities were the major problem. It is therefore, recommended that loan facilities should be provided to the intermediaries, IT service should be developed up to village level and transportation cost should be keep reasonable.

Impact of Hybrid Rice and Maize Seed in Cereal Production System in Bangladesh

The present study was undertaken on hybrid rice and maize seed production and marketing scenario, farmers' perception and efficiency of hybrid rice and maize producers. The goal of the project will be achieved after three years (2014-15, 2015-16 and 2016-17). In first year, data of 20 seed dealers and 200 farmers have been collected and analyzed from Dinajpur and Sherpur on hybrid rice. In addition, data of major 10 seed companies have been collected and analyzed. More than 4 thousand tons of hybrid rice seed have been imported by the 10 seed companies in 2014-15 which is about 40% of total import of hybrid rice seed (about 10000 tons). All the seed companies sale their seed through distributer, seed dealers and retailers. Only BADC (SL 8 H) produce hybrid rice seed but it is not more than 10% of total import. Farmer's gross return and gross margin have been increased using hybrid rice seed compared to HYV rice seed. Gross margin was 22% higher in Dinajpur and 28% in Sherpur using hybrid rice seed over HYV seed. The results of stochastic frontier production function (SFA) indicated that translog production function was preferred and the parameter γ and σ^2 of the maximum likelihood estimates are significant which means that inefficiency effects are present in the analysis and the traditional "average" production function is not an adequate representation of the data.

Hence, technical inefficiency effects have significant impact on output. These results suggest that there is a substantial scope for increasing hybrid rice production in the country using hybrid rice seed. Farmers are happy by producing hybrid rice varieties as they are higher yielder. Most of the farmer's opinion is, if per kg price of rice increase, then area of hybrid rice will be increased.

Assessment of Climate Variability Stresses, Adaptation Strategies and Capacity of the Farmers in Selected Coastal Areas of Bangladesh

Climate change and climate variability causes different biotic and abiotic stresses on crops and farmers' livelihood. Coastal farmers adopted various adaptation strategies to reduce these adverse effects. Data and information regarding these issues are scarce in Bangladesh. Therefore, the study was conducted in Patuakhali and Pirojpur district during 2014-2015 to identify climate variability stresses; evaluate adaptation system and capacity of the farmers to reduce different stresses effect; find out the factors that determine the adaptation capacity of the farmers; and identify the problem of adaptations. A total of 120 farmers taking 60 from each district were selected randomly. The study revealed that draught (100%) and uneven rain (100%) were the severe stresses in the study areas. Farmers responded that 62% crop loss occurred due to flood followed by water salinity (51%) and soil salinity (35%). Yield differences between adverse climatic condition and normal climatic condition were ranged from 40 to78 percent. Education, family members, availability of credit facilities, and training were the significant determinants of adaptation capacity of the farmers. In order to adapt adverse situation, farmers adopted different measures like reserve rain water (13%), make ring well (11%), use of salt tolerant variety (34%), irrigation (22%), develop drainage system (49%), use pesticides (100%), use insecticides (100%), and temporary migrate/ switch to other occupation (75%).

14 PLANT GENETIC RESOURCES

Exploration and collection of germplasm

Exploration and collection of multicrop germplasm were conducted in thirteen districts namely Munshiganj, Manikganj, Khagrachari, Rangamati, Kishoreganj, Gazipur, Jhalokathi, Pirozpur, Rajbari, Madaripur, Shariatpur, Dinajpur, and Dhaka. The landraces and primitive crop cultivars/germplasm were mostly collected including indigenous vegetable and other crop plants. A total of 394 germplasm of 51 different crops were collected during 2014-15.

Exploration and collection of chilli, cucumber and melon germplasm

A multi-crop exploration and collection program was carried out on chilli, cucumber and melon germplasm at 16 districts in Bangladesh under AFACI-IMPGR project during 2014-15. Four hundred twenty germplasm of three target crops (chilli-203, cucumber-36 and melon-181) were collected from 38 upazilas/thanas of Pirozpur, Jhalokathi, Barisal, Madaripur, Shariatpur, Manikganj, Munshiganj, Kishoreganj, Dinajpur, Panchagarh, Bogra, Dhaka, Gazipur, Feni, Rangamati and Khagrachari districts. The germplasm were collected from field, threshing floor, garden, farm store, market etc. The status of the sample was mostly land races. The samples were collected as seeds and fruits from individual plant or population. Passport descriptors like name of donor with ethnic group, village, union, upazila, district, latitude and longitude were recorded during collection. A 'Passport Data Form' having passport descriptors 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

The experiment was conducted with 51 germplasm of hyacinth bean (*Lablab purpureus* L. Sweet) to estimate the genetic diversity. Green and purple colours were found in hypocotyl, epicotyl and leaf vein. No pigmentation, almost solid and extensive pigmentation were found on main stem. Absence and presence of leaf anthocyanin were observed among the germplasm. Pale to dark green leaf colour intensity were found. Variations were observed in ramification index and raceme position. The germplasm were exhibited white (67%) and purple (33%) flower. Edible pod colour was green (59%), green with purple margin (24%), yellow-green with purple margin (2%), purple (14%) and white (2%). Flat (76%) and elongate (24%) edible pod shape having straight (63%), slightly curved (35%) and curved (2%) pod curvatures were observed. Seed colour such as black (63%), brown (22%), yellow-white (8%), grayed-orange (6%) and bicolour-brown with cream (2%) were found. Small (33%), medium (65%) and large (2%) seed size along with ovoid (67%) and flat (33%) seed shape were exhibited. Days to first flowering ranged from 53 to 100 days while edible pod stage ranged from 78 to 129 days. Significant 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 observed in edible pod length (7.02 to 14.29 cm), width (1.71 to 4.21 cm) and pod weight (4.40 to 17.87g). The germplasm were produced 80 to 530 pods per plant and 3 to 5 seeds per pod. The highest CV was observed in number of pods per plant (56.68%) and the lowest was observed in number of seeds per pod (9.53%). Hierarchical and non-hierarchical cluster analysis was done. The

51 germplasm were grouped into five non-hierarchical cluster clusters. Some promising germplasm were identified.

Characterization of turmeric germplasm

Twenty eight germplasm of turmeric (*Curcuma longa*) showed variations in both qualitative and quantitative characters. In case of qualitative characters, all the germplasm of turmeric showed variations in the characters except mid-rib prominence. This character showed no morphological variations among the germplasm. The highest variability was observed in flower color viz. light purple-12, green-1, white green-8, white purple-1 and light green-4. All the turmeric germplasm also showed quantitative variations in the characters. The highest CV% was recorded from weight of mother rhizome (85.66) and the lowest was recorded from days to flowering (10.35). This indicated that a wide variation was present in weight of mother rhizome. The remaining characters also showed high CV% which showed that there were much variations present in the germplasm.

Characterization of grass pea germplasm (Set I)

The study was conducted at the Experimental field of Plant Genetic Resources Centre, BARI, Gazipur over the period from November, 2014 to April, 2015 with 100 accessions of grass pea to study the variability of important traits. Colour variations were observed in stems, leaves, flower, calyx and pod. There was difference among the accessions in terms of plant growth habit and seed shape. Maximum accessions (45%) showed the semi-erect growth habit while the least number of accessions (10%) exhibited semi-erect growth habit .Maximum (44%) accessions gave the purple- green in case of stem color while it was green (52%)in respect of leaf. Broad-linear pod shape was observed in maximum (48%) accessions while the least number of accessions (3%) showed the broad-elliptical pod shape. In case of seed shape, the rhomboid shape was found in most accessions (61%) while triangular shape was exhibited by the minimal number (3%) of accessions. Significant variations were observed in most of the important quantitative characters including pod maturity duration, number of pods per plant, 100 seed weight as well as yield per plant. The required days for pod maturity varied from 98 to 118 days and the accession BD-4755 took the minimal (99) days for maturity. The yield per plant varied from 12.72 to 37.57 days with the highest yield by BD-3664. The highest coefficient of variation was found in yield per plant (29.58%) and the lowest from days to pod maturity (6.97%).

Characterization of grass pea germplasm (Set II)

One hundred (100) accessions of grass-pea (*Lathyrus sativus* L.) were characterized at plant Genetic Resources Centre (PGRC), RARS, Jamalpur. In qualitative variation was predominantly present in all characters except stem colour, leaf type, and flower colour. In quantitative traits highest plant height in accession BD-5387 (110 cm) followed by the characters length of primary branch in accession BD-5394 (93cm), pod length in accession BD-5068 (3.5cm), pod width in accessions BD-5414 (2.6cm), 100-seed weight in accession BD-5367 (07g) and number of seed per pod in accession BD-5068 (5). Maximum number of primary branch present in accession BD-4517 (16) followed by the characters number of pods per plant in accession BD-5308 (39). Early flowering and early maturity was showed in accessions BD-5355(57 days) and BD-5453(96 days). The highest mean, standard deviation (SD) and coefficient of variation (CV %) were observed days to maturity (110.01), Plant height (13.54) and number of primary branch (26.99). The level of diversity detected and the potential use of this germplasm in breeding programmed and discussed.

Characterization of grass pea germplasm (Set III)

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishwardi, Pabna during Rabi season of 2014-15 to identify the important traits of grasspea accession. The experiment involved 101 grass pea accessions. 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 grass pea accessions. The first flower initiation was earlier in BD-5507 (54 days) and a day to 50% flowering was earlier in BD-5613 (70 days). The earlier maturity was in BD-5613 (112 days) than the other accessions. BD-5564 produced significantly the highest number of seeds per plant. The highest seed yield (35.38 g/ per plant) was recorded from BD-5562 grass pea accession and the lowest yield (5.85 g/ per plant) from BD-5499 grass pea accession. Variations among grass pea accessions were observed in different qualitative characteristics like plant pigmentation were observed in stems, leaves and flowers. Maximum stem colour was light green for 17 accessions, green for 47 accessions, purple green for 37 accessions. Variations in plant growth habit like prostrate, spreading, semi-erect and erect were observed. Different flower colour was white blue for 28 accessions, blue for 35 accessions, violet blue for 22 accessions, violet for 16 accessions. Different seed shape was rhomboid for 97 accessions, square for 3 accessions, and obtriangular for 1 accession were observed.

Characterization of grass pea germplasm (Set IV)

Performance of 100 grass pea (*Lathyrus sativus*) was studied at the Regional Agricultural Research Station, Jessore during the rabi season of 2014-15. Morphological variations were observed among the accessions for 12 qualitative traits viz. seedling vigor, plant growth habit, stem color, leaf color, leaflet shape, flower size, flower color, pod shape, immature pod color, mature pod color, seed size and seed coat color along with seed yield. Considering the seed yield and overall performance BD-5684, BD-5782 and BD-5783 may be selected for utilization in the improvement of grass pea.

Characterization of chickpea germplasm

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during Rabi season of 2014-15 to identify the important traits of chickpea accession. The experiment involved 102 chickpea accessions. Variations were observed in respect of days to first flowering, days to 50% flowering, days to maturity, plant canopy height, number of seeds per pod, 100-seed weight and yield per plant among chickpea accessions. The first female flower initiation was noticed in BD-6102 (59 days) and days to 50% flowering was earlier in BD-6111 (76 days). The earlier maturity was in BD-6105 (124 days) than the other accessions. BD-6159 produced significantly the highest number of seeds per plant. BD-6051, BD-6083, BD-6088, BARI chickpea-9, BD-6132, BD-6137, BD-6135, BD-6143, BD-6157, BD-6159 and BD-6169 were high yielding (40.50− 67.32 g per plant). The highest seed yield (67.32 g per plant) was recorded from BD-6135 chickpea accession and the lowest yield (4.42 g per plant) from BD-6164 chickpea accession. Variations among chickpea accessions were observed in different qualitative characteristics like plant pigmentation were observed in stems, leaves and flowers. Growth habit was erect for 2 accessions (1.96%), semi-erect for 32 accessions (31.37%), semi-spreading for 49 accessions (48.03%), spreading for 15 accessions (14.70%) and prostrate for 4 accessions (3.92%). Leaf type was simple for 31 accessions (30.39%) and multipinnate for 71 accessions (69.60%). Flower colour was pink for 49 accessions (48.03%), light pink for 10 accessions (9.80%), dark pink for 42 accessions (41.17%) and white were observed for 1 accession (0.98%). Seed shape was angular; rams head for 24 accessions (23.52%) and irregular rounded rest was owl’s head for 78 accessions (76.47%).

Characterization of chilli germplasm

The experiment was conducted with 75 germplasm of chilli in the experimental field at Plant Genetic Resources Centre (PGRC) of BARI, Joydebpur, Gazipur, during winter 2014-15 to find out the variation in the germplasm. The germplasm of chilli was collected from different regions of Bangladesh. All the number of qualitative characters showed distinct variation among the germplasm except cotyledonous leaf shape, corolla spot, fruit persistence and neck at base of fruit. The maximum variation was observed in hypocotyl color, stem color before transplanting, leaf pubescence density and fruit shape at blossom end. Hypocotyl color diversed in Green (4%), ¼ purple from the base (14%), ½ purple from the base (22.67%), and Purple (36%). Stem color before transplanting varied in maximum groups viz. Green (4%), Green with few purple strips (32%), Green with many purple strips (22.67%), Purple (4%), Mixture (Green+Purple) 37.33%, Glabrous (18.67%), Sparse (46.67%), Intermediate (13.33%) and Abundant (21.33%) types of leaf pubescence density were found among the accession. Fruit shape at blossom end varied in four groups such as Pointed (82.67%), Blunt (9.33%), Sunken (2.33%), Sunken & pointed (2.67%).Quantitatively highest variation was observed in yield per plant and number of fruits per plant (CV- 99.14%). Considering all the parameter studied the germplasm AM-15 (227.38g), RISA-76 (159.14g) RISA-109 (133.26g) and AM-17 (121.36g) were found as the best yielder.

Characterization of amaranth germplasm

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during 2014-15 to know the diversity of 40 accessions of amaranth (*Amaranthus* spp). Among these accessions leaf (5%), stem (90%) and grain (5%) amaranth were identified. Based on the stem quality the accessions were also classified as hard (15%), medium (5%) and soft (80%) on the basis of fiber. Qualitative character variation was found in branching index, stem and leaf pubescence, leaf shape, leaf margin, terminal inflorescence shape, terminal inflorescence attitude and inflorescence density index**.** Different color variations were exhibited in stem green 10% and pink or purple 90%, leaf entire lamina purple or pink 32.5%, margin and vein pigmented 35%, normal green 10% and other 22.5%, 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%. The highest CV was found in terminal inflorescence lateral length (117.64%) and the lowest in germination period (6.64%).

Characterization of horse gram germplasm

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during 2014-15 to know the diversity of 30 accessions of horse gram (*Macrotyloma uniflorum* Lam). Qualitative character variation was found in seed color and mottling on seed**.** Brown (40%) and mixed (60%) seed color were exhibited among the accessions. Mottling on seed showed absent (53.33%), light (6.66%) and medium (40%). All other qualitative characters showed no variation among the accessions. The maximum CV was found in Pods per plant (46.37%) and the lowest in days to flowering (7.71%).

Characterization of snake gourd germplasm

Thirty two conserved and collected snake gourd (*Trichorasthes anguina* L.) germplasm were evaluated for characterization at Plant Genetic Resources Centre (PGRC). BARI, Gazipur. The principle aim of the experiment was to know variability and genetic diversity of the selected germplasm. The germplasm were collected from different regions of Bangladesh. No variation was found among the accessions in leaf pubescence, sex type, stem shape, leaf shape, leaf pattern, tendril, tendril type and tendril branching. A total of 12 quantitative traits were evaluated. The highest variation (CV-79.62%) observed in yield per plant which was followed by total fruit weight (38.36%) and no. of fruits per plant (36.29%). Yield per plant ranges from 0.30 kg to 6.01 kg with an average 1.44 kg. Highest number of fruit was found in accession BD-4441 which was followed by BD-1665, BD-1667 and BD-1668. The maximum vine length was found 675cm in accession BD-1670. Longer snake gourd (55.38 cm) recorded in accession BD-10395.

Characterization of foxtail millet germplasm

One hundred forty six accessions of foxtail millet (*Setaria italica* (L.) P. Beaur) were characterized at plant Genetic Resources Centre (PGRC), BARI, Gazipur during winter, 2014. Variability showed in different plant characters (growth habit, plant pigmentation, leaf colour), inflorescence characters (inflorescence lobes, inflorescence bristles, lobe compactness, inflorescence compactness, inflorescence shape, and inflorescence colour) and seed characters (seed colour). In quantitative characters, average plant height was 104.64 cm 2.1 to 6.5 number of tillers per plant, 6.00 to 30. 4 cm inflorescence length and 10.0 to 34.8 cm peduncle length were recorded among the accessions. Co-efficient of variation was higher in number of tiller per plant (31.99%) followed by inflorescence length (24.01%) and the lowest in days to flowering (5.59%).

Characterization of mungbean germplasm (Set I)

Twenty two accessions of mungbean were characterized at Plant Genetic Resources Centre, BARI, Gazipur to find out the estimation of genetic variability by using morphological parameters. Both qualitative and quantitative characters showed high phenotypic variation in most of the plant characteristics of mungbean germplasm. Qualitative variations were predominately present in all characters except calyx colour, immature pod colour, pod beak shape, and constriction of pod between seeds. In quantitative character, pods per plant and hundred seed weight showed maximum coefficient of variation. So, these result indicated a wide variation is present among the accessions and these germplasm may be used in variety development.

Characterization of mungbean germplasm at Ishurdi (Set II)

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during kharif 1season of 2014 to identify the important traits of mungbean accessions. The experiment involved thirty nine mungbean germplasm. Variations among mungbean accessions were observed in different qualitative characteristics like growth habit was erect for 12 accessions (30.77%), semi-erect for 22 accessions (56.41%) and spreading for 5 accessions (12.82%). Terminal leaflet shape was deltate for 7 accessions (17.94%), ovate for 15 accessions (38.46%), ovate-lanceolate for 4 accessions (10.25%) and rhombic for 3 accessions (7.69%). Pod attachment to peduncle was pendant for 5 accessions (12.82%), sub-erect for 7 accessions (17.94%) and erect for 27 accessions (69.23%). Pod beak shape was hook for 30 accessions (79.92%) and knob for 9 accessions (23.07%). Seed colour was light green for 7 accessions (17.94%), green – brown for 28 accessions (71.79%), brown for 2 accessions (5.12%), and black for 2 accessions (5.12%). Seed shape was globose for 4 accessions (10.25%), ovoid for 7 accessions (17.94%), drum–Shaped for 26 accessions (66.67%) and other for 2 accessions (5.12%). Variations among mung bean accessions were observed in respect of days to first flowering, Days to first mature pod, plant height, number of seeds per pod, number of seeds per plant, 100- seed weight, seed yield per plant. The first flower initiation was noticed in BD-6876 (33 days). The highest seed yield (17.77 g per plant) was recorded from BD-6895 and the lowest seed yield (4.04 g per plant) from BD-10026.

Evaluation of mustard germplasm against salt stress

Screening a large number of germplasm for salt tolerance was achieved through the identification of salt movement in the plant. The salt stress influenced plants growth and productivity, this metabolism were likely due to osmotic effects of the salt in the soil solution. In this study the character showed comparative performance among the treatments 0, 4, 8 and 12 ds/m. The plant height showed maximum 36.11 in control and the minimum 8.66 in 12 ds/m. Number of primary branch per plant, number of leaf per plant, number of pod per plant and root length were gradually detoured up to 12 ds/m among the twenty five accessions. The mean of leaf area was obtained 79.07 cm^2 in control followed by 67.05 cm^2in 4 ds/m, 42.25cm^2 in 8 ds/m and 20.55cm^2 in 12 ds/m. Leaf fresh weight per plant was found maximum 5.4 g in control followed by 5.04g in 4 ds/m, 0.76g in 8 ds/m and 0.68g in 12 ds/m. The mean value of seed yield 12.84g in 8 ds/m and 0.33 g in 12 ds/m. Lastly, it was identified that the germplasm BD-6950, BD-10108, BD-10115, BD-7104, BARI sharisa-13, BARI sharisa-16, P2, P4 and P6 were tolerant under 12 ds/m salt concentration level.

Characterization of yard long bean germplasm

Thirty five accessions of yard long bean were characterized at Plant Genetic Resources Centre of BARI, Gazipur during Kharif-1 of 2014 to evaluate their genetic performance within the germplasm collected from different parts of the Bangladesh. The accessions showed vast variation in the qualitative characters of growth habit, terminal leaf shape, pod color, pod surface, seed shape, pod length, girth and pod weight etc. The highest coefficient of variation (38.01) was observed in pod length, pod weight, fruit weight and lowest coefficient of variation (12.94) found in days to harvest green pod and days to flowering respectively.

Molecular characterization of chilli germplasm

This experiment was carried out with 47 germplasm of chilli at Molecular Biology Lab., Plant Genetic Resources Centre of Bangladesh Agricultural Research Institute, Gazipur. An extensive research programme has been initiated for the estimation of genetic diversity, identification and discrimination of 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. A total of 115 collected germplasm and about 50 microsatellite markers will be used in this experiment. Initially, twenty primer pairs with clear and expected amplified product sizes were selected. This work is a progress report of the utilization of one microsatellite marker CL-CAMS-351. The marker was found to be polymorphic. Using this primer across 47 germplasm and a total of 7 alleles size ranging from 191 bp to 211 bp was detected. Forty seven germplasm were separated into 14 groups based on different allele size. Germplasm collected from same area were drawn together in the same group. Both homozygosity and heterozygosity was found across the 47 germplasm. Variation was observed in SSR banding patterns and it could be possible due to different geographical sources and also different morphological traits. After using higher number of microsatellite markers selected from different chromosome, it could be possible to produce unique DNA profiles of chilli germplasm and estimate genetic variation among the germplasm.

Distribution of germplasm

Germplasm distribution is one of the important activities of Plant Genetic Resources Centre (PGRC). The centre distributed 1067 accessions of 23 crops during 2014-2015. Among them, 10 accessions were snake gourd, 9 hyacinth bean, 100 wheat, 20 lentil, 30 chickpea, 20 sunflower, 135 mung bean, 30 black gram, 150 sesame, 60 sweet gourd, 33 maize, 3 cabbage, 10 tomato, 4 french bean, 20 brinjal, 79 chilli, 10 spinach, 105 mustard, 50 ridge gourd, 40 sponge gourd, 98 okra, 50 ash gourd, and 1 cauliflower. Ten to hundred seeds /5-10 gm per accession were supplied to the users. The germplasm users were MS and Ph.D students, plant breeder, horticulturist, researchers, and teachers of different Universities.

Conservation of germplasm in active and base collection

Plant Genetic Resources Centre (PGRC) act 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 -20^{0}C. Generally the seeds were dried at 6-8% moisture content before storing. The centre is maintained 10085 accessions of 137 different agro-horticultural crops in the gene bank and in the field gene bank. Among them, 1727 accessions are cereals, 3460 pulses, 455 oilseeds, 3902 vegetables, 197 spices, 92 fruits, 58 other crops and 194 vegetative or recalcitrant seeded plants. Seed viability was monitored by testing germination from the stored germplasm. Accessions with less than 80% viability and/or less quantity of seed were regenerated.

Monitoring of active collection

Viability of 1175 accessions of chickpea, okra, brinjal, amaranth, maize, muskmelon, spinach, grass pea, ash gourd, lentil, long bean, sweet gourd, pigeon pea, soybean, bitter gourd, snake gourd, and mustard were tested during 2014-15 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 1175 accessions, 348 accessions were in <40%, 163 accessions in 41-79% and 664 accessions in 80-100% germination. Among the accessions of chickpea-178, amaranth-10, maize-8, muskmelon-54, spinach-15, grasspea-35, lentil-226, long bean-63, pigeon pea-12, and snake gourd-21 were found high germination percentage (80-100%). But the germination percentage of okra, sweet gourd, soybean, bitter gourd, and mustard were observed poor (<40%). The accessions having less than 80% germination will be regenerated in the next year.

Regeneration of newly collected and conserved accessions of amaranth

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2014-15 to regenerate the newly collected (14) and conserved accessions (20) of amaranth (*Amaranthus* spp). Leaf (8), stem (22) and grain (4) amaranth were identified during regeneration. Seven qualitative data were recorded. Different color variations were exhibited in stem purple (25) and green (9), petiole dark purple (12), green (7) and purple (15), leaf entire lamina purple (20), normal green (6), margin and vein pigmented (5), dark green (2) and other (1), inflorescence greenish pink (10), green (9), red (6), pink (5), red (3) and yellow (1) and seed red (11), black (21), pale yellow (1) and brown (1). Seeds were obtained 19 to 592.5 g from the newly collected (14) and conserved accessions (20) of amaranth. Seeds were cleaned, dried and conserved in the genebank.

Regeneration of newly collected germplasm of brinjal

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2014-15 to regenerate the 11 newly collected germplasm of Brinjal (*Solanum melongena* L.). Two spines brinjal (M-07 and KASI-99) were identified among the germplasm during regeneration. Qualitative character variation was found in leaf blade lobing intermediate (6), strong (4) and weak (1), leaf blade tip angle obtuse (4), intermediate (4) and acute (3), fruit length/breadth ratio broader than long (1), as long as broad (4), slightly longer than broad (3), twice as long as broad (1) and three times as long as broad (2), fruit curvature none (10) and slightly curved (1) and fruit apex shape rounded (5), protruded (4) and depressed (2). Different color variations were exhibited in corolla bluish violet (4), greenish white (1), pale violet (1) and light violate (5), in fruit milk white (3), green (6) and purple (2). Seeds were obtained 12.17 to 172.9 g from the collected germplasm of Brinjal. Seeds were cleaned, dried and conserved in the genebank.

Regeneration of newly collected germplasm of cauliflower

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2014-15 to regenerate the 1 newly collected germplasm of Cauliflower (Brassica oleracea var. botrytis L.). Nine qualitative data were recorded. The germplasm showed elliptic leaf shape, dark green leaf color. Leaf lobing was absent. Round shape and cream colour curd was found. Curd compactness was medium. Yellow color flower, erect type silique was recorded. The width of midrib was narrow. Seeds were obtained 315.51 g from the collected germplasm. Seeds were cleaned, dried and conserved in the genebank.

Regeneration of newly collected germplasm of chinese cabbage

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2014-15 to regenerate the 1 newly collected germplasm of Chinese cabbage (*Brassica chinensis* L.). Seven qualitative data were recorded. The germplasm showed non heading plant growth habit, green leaf color, prominent leaf venation, crenate leaf margin, light green vein color and white midrib color. Yellow flower color was observed. Seeds were obtained 494.94 g from newly collected germplasm. Seeds were cleaned, dried and conserved in the genebank.

Regeneration of newly collected germplasm of tomato

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2014-15 to regenerate the 2 newly collected germplasm of Tomato (*Solanum lycopersicum*). The two germplasm showed variation in exterior colour of immature fruit, predominant fruit shape, fruit blossom end shape and seed color. In collection no. RISA-144, a few plants showed variation in color and shape, they were separated with by numbers. Eight qualitative data were recorded. Seeds were obtained 176.04 g (RISA-144) and 3.69 g (AI-03) from the collected germplasm. Seeds were cleaned, dried and conserved in the genebank.

Regeneration of chilli germplasm

One hundred and twelve accessions of conserved and collected chilli germplasm were regenerated at Plant Genetic Resources Centre (PGRC). BARI, Gazipur to check the status of germplasm by ensuring its quality, quantity and viability. A total of 112 accessions were found viable among 166 accession of chilli germplasm. All the viable accession regenerated perfectly producing good viability, vigorous growth and morphological variation. Nine (09) qualitative and one (01) quantitative character were recorded. All the qualitative character showed wide range variation among the accession. The maximum variation found in corolla color. Seed yield was estimated to achieve total seed weight from the accession. BD-2030, AM- 15, BD-2006, AM -17, BD-2034, BD-2026, RT-7, RT- 6 and RISA- 76 were found as the best seed yielder.

Regeneration of newly collected and conserved accessions of cowpea, horse gram, fennel, bati shak, cabbage, blackcumin and napa shak

The experiment was conducted at the experimental field of Plant Genetic Resources Centre, BARI, Gazipur during 2014-15 including some crops namely as black cumin-6, fennel-2, Napa shak -8**,** horse grami-1, cabbage-1, batishak-1, garlic-1 and cowpea-9 which were successfully grown to assist the regeneration and conservation program. All the accessions were planted from 18 November to 23 November, 2014 with recommended practices to get adequate quantity of seed for future use. The crops were harvested at time to time for each accession. Proper activities were done during drying, cleaning and curing the seed. Some qualitative and quantitative characters were recorded to assess the overall performance for getting good quality seed.

Regeneration of conserved and newly collected sesame germplasm

An experiment on regeneration of 48 sesame germplasm was conducted during Kharif-1 of 2014. Quantitative variations were observed in all the characters. BD-10167 produced higher (360gm) amount of seed. Eleven accessions showed earliness in first flowering and pod initiation. Pods per plant was highest (272.5) in BD-6961 and lowest (69) in BD-6984. Higher number of seeds per pod (79.5) was found in BD-6968. Seeds were cleaned, dried and conserved in the gene bank.

Regeneration of newly collected germplasm of barley, prosomillet, finger millet and alim shak

An experiment was conducted at the Plant Genetic Resources Centre, BARI, Gazipur during Rabi season of 2014-15 to regenerate the 13 germplasm of four crops viz. barley, proso millet, finger millet and alim shak (indigenous vegetable). Some of the qualitative and quantitative characters were recorded for using as reference data. Some of variations was also found in all collected materials under each crop. Adequate amount of seeds were harvested for conservation and future use.

Maintenance and development of field gene bank

A total of 194 accessions of 57 crops including indigenous and exotic germplasm have been conserved in the field gene bank of Plant Genetic Resources Center (PGRC). The intercultural practices were done as and when necessary. Neither major insect pest nor diseases were found during the last year. The field gene bank has been maintained since 1985.

In vitro conservation of potato

The experiment was conducted with 10 varieties of potato (*Solanum tuberosum* L.) to evaluate the performance of *in vitro* conservation. Nodal explants of potato varieties were cultured for 3 months on MS medium containing 20g/l sorbitol. The varieties produced 78 to 100% roots and 50 to 100% shoots within 10 days. Number of leaves (10 to 20), shoots (2 to 4) and roots (3.4 to 12.4) were obtained from the varieties. The maximum shoot length (11.9 cm) was exhibited in BARI Alu-25 and the minimum shoot length (5 cm) obtained from BARI Alu-21.

In vitro conservation of mint

Nodal explants of three genotypes namely MP-1, MP-2 and MP-3 of mint (*Mentha* spp.) were cultured at 22 ± 1°C on MS medium supplemented with 20 mg/l sorbitol for mint conservation. After three months culture, the highest of 100% shoot and root initiation was observed in both MP-1 and MP-2 while the lowest 99%, shoot and root initiation was found in MP-3 within 11 days. The maximum number of leaflets (26.4) and shoots (5.8) was observed in MP-2 and the minimum leaflets (42.4) and shoots (3.4) was found in MP-3. The genotypes produced 4.62 to 7.36 cm shoot length with an average of 5.66 cm. The highest number of roots (25.6) was observed in MP-2 while the lowest (18.20) from MP-3. The genotypes produced an average of 6.13 cm root length. Sorbitol can be used *in vitro* conservation of mint.

Documentation of passport information of PGR

Passport information of 1956 collections both indigenous and exotic on 82 crops was recorded at the Documentation Laboratory of Plant Genetic Resources Centre during 2014-15.There are 837 accessions and 1119 registered germplasm. Among them, information on 21 accessions from cereals, 50 accessions in pulses, 11 accessions in oil seeds, 698 accessions in vegetables, 23 accessions in spices, 2 accessions in fruit and 27 accessions in other crops are available in the information system. The maximum of 223 hyacinth bean accessions from 26 districts and 329 chilli registered germplasm from 39 districts were recorded. Passport information on ten exotic collections are documented. The Centre recorded as much possible of 32 descriptors information in Genebank data base software. The important passport information are crop name, accession number, collectors number, date of collection, name of village, thana, district, country, donors and collectors name etc. All information are available in the local area network.

15 ON-FARM STUDIES

On-Farm Soil Fertility Management

Development of fertilizer recommendation for Potato-Maize T. Aman cropping pattern in high ganges river floodplain

The experiment was carried out at the MLT site, Shibpur, Puthia, Rajshahi during the year of 2014-15 to verify the present fertilizer recommendation for Potato-Maize T. Aman 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 surrvey) were employed for the experiment. The experiment was laid out in RCB design with six dispersed replications. The BARI Alu 7, BARI Hybrid Maize 9 and BRRI dhan33 were selected for potato, maize and rice, respectively. System productivity in terms of REY was estimated for each treatment. Before conducting the experiment soil sample was collected at the depth of 0-15 cm for laboratory analysis.Maximum REY was estimated in T_3 (30.56 tha^{-1}) which was very close to that of T_2 (30.35 tha^{-1}) and minimum in T_4 (25.77 tha^{-1}). REY in T_3 and T_2 was about 18.58% and 17.78% higher than T_4, respectively. Gross margin in T_2 found little bit higher than that of T_3 despite of having higher gross return in T_3 as 50% higher dose of fertilizer put an extra cost to this treatment. Thus higher MBCR was recorded from T_2 and the lower from T_4 treatment.

Development of fertilizer recommendation for potato in Potato-Jute-T. Aman cropping pattern in faridpur

The experiment was conducted at Kaderdi village of Boalmari upazilla, Faridpur district under Low Ganges River Flood Plain soil (AEZ-12) during the year of 2013-14 and 2014-15 to determine an appropriate fertilizer dose of potato under Potato–Jute-T. Aman rice cropping pattern for increasing the yield and economic return of potato. The experiment was laid out in a RCB design dispersed with six replications. The six treatments were T_1: STB fertilizer dose (FRG, 2012), T_2: TCRC recommended dose for seed plot technique, T_3: Recommended doses of fertilizer based on FRG, 2005 in cropping pattern, T_4:50 % of T_3, T_5: Farmers' practices and T_6: absolute control. The tested variety of potato was BARI Alu 25, (Astrix). Haulm pooling was done at 89 to 93 DAP in 2013-14 and 81-82 DAP in 2014-15. Harvesting was done at 95 to 101 DAP in 2013-14 and 90-91 DAP in 2014-15. Randomly ten plants from each plot were tagged to take records on different agronomic parameters of potato. The highest mean tuber yield (21.81 t ha^{-1}) was obtained from TCRC recommended dose (T_2) and the lowest yield (10.96 t ha^{-1}) was accounted from T_6. In terms of cost and return, T_2 showed the highest mean gross margin (Tk. 55555 ha^{-1}) .The total variable cost was maximum (Tk. 189070 ha^{-1}) in farmers' practice (T_5) but produced lower yield than T_2.

Development of fertilizer package for Potato-T. Aus-T. Aman rice cropping pattern in eastern surma-kushiara floodplain

The experiment was carried out at FSRD site, Jalalpur, Sylhet and MLT sites, Moulvibazar and Sunamganj during the year of 2014-15 that was initiated in 2012-13 to develop a cropping pattern based fertilizer dose for Potato-T. Aus-T. Aman rice in Sylhet region. There were four nutrient packages i.e., T_1: Soil test based (STB) fertilizer dose for high yield goal, T_2: T_1+ CD 5 t ha^{-1}, T_3: T_1 along with CD 5 t ha^{-1} in IPNS approach and T_4: Farmers' practices as control. The experiment was laid out in a RCB design with six dispersed replications. The trial was started with potato (var. Diamant) and followed by T. Aus rice (var. BRRI dhan 48) and T. Aman rice (Binadhan 7) in the subsequent season. Potato (var. Diamant) were sown on 20-25 November. The tubers were planted by maintaining the spacing of 60 cm × 15 cm. The crop was harvested at maturity on 2-5 March. In Jalalpur location, the highest tuber yield of potato was recorded in T_3 (25.79 t ha^{-1}) followed by T_2 (23.52 t ha^{-1}) while the lowest tuber yield was found in T_4 (19.34 t ha^{-1}). But, the highest grain yield of T. Aus and T. Aman rice (5.05 and 3.85 t ha^{-1}) were produced by T_3 and T_2, respectively. However, T. Aman rice equivalent yield was recorded higher in T_3 that was followed by T_2. In case of Moulvibazar, the highest tuber yield of potato was observed in T_3 (24.10 t ha^{-1}) that was followed by T_2 (20.58 t ha^{-1}) while the lowest tuber yield of potato was found in T_4 (17.25 t ha^{-1}). Interestingly, the grain yields of T. Aus and T. Aman rice (4.43 and 3.94 t ha^{-1}, respectively) in the year 2013-14 were the highest in T_2 (Table 4). The equivalent yields of potato and T. Aman rice in this location were recorded higher in T_3 that was followed by T_2. In Sunamganj, the highest tuber yield of potato was also recorded in T_3 (23.49 t ha^{-1}) that was followed by T_2 (20.90 t ha^{-1}) while the lowest tuber yield of potato was found in T_4 (18.47 tha^{-1}) during 2013-14. The rice equivalent yield was found higher in T_3 that was closely followed by T_2. In the year 2014-15, tuber yields of potato significantly influenced by the treatments and variation was also found over the locations. In Jalalpur location, the highest tuber yield of potato was recorded in T_3 (14.75 t ha^{-1}) followed by T_2 (13.63 t ha^{-1}) while the lowest tuber yield was found in T_4 (12.23 t ha^{-1}). Similar trend was also observed in Sunamgonj location and it was 16.46 t ha^{-A1} in T_3. But in Moulvibazar, the highest tuber yield was found in T_2 (17.82 t ha^{-1}) that was closely followed by T_3 (16.12 t ha^{-1}). However, among locations, the tuber yield of potato was higher in Moulvibazar than that of others. It might be due to the variation of soil type and climate condition. The mean tuber yield of three locations showed that T_2 gave the highest yield (15.89 t ha^{-1}) which was very close to T_3.

Integrated nutrient management for Chickpea-T. Aus-T. aman in medium highland under rainfed condition in sylhet region

A field experiments was carried out at farming system research and development (FSRD) site, Jalalpur and multi-location testing (MLT) sites, Moulvibazar and Sunamgonj location during 2013-14 and 2014-2015 to develop a cropping pattern based fertilizer dose for Chickpea T. Aus-T. Aman rice in Sylhet. There were four nutrient packages i.e., T_1: Soil test based (STB) fertilizer dose for high yield goal, T_2: T_1+ CD 5 t ha^{-1}, T_3: T_1 along with CD 5 tha^{-1} in IPNS approach and T_4: Farmers' practices as control. The unit plot size was 4m x 5m. The trial was started with chickpea (var. BARI Chola 5). The seeds of chickpea were sown on 5-11 December. The crop was harvested at maturity on 3-8 April. In Jalalpur location during 2013-14, the highest seed yield of chickpea (1.36 tha^{-1}) and grain yield of T. Aus rice (4.92 t ha^{-1}) was obtained from T_2 while T_3 gave the highest T. aman rice yield (3.98 t ha^{-1}) that was identical to T_2 (3.74 tha^{-1}). In Moulvibazar during 2013-14, higher seed yield of chickpea (1.37 t ha^{-1}) and grain yield of T. Aus rice (4.39 t ha^{-1}) were recorded the highest in T_3. But, the grain yield of T. Aman rice (4.21 t ha^{-1}) was the highest in T_2. In Sunamgonj, the highest seed yield of chickpea was recorded in T_3 (1.32 t ha^{-1}) but the grain yields of T. Aus and T. Aman rice (4.06 and 4.10 t ha^{-1}), respectively were gained the highest in T_2. On the contrary, in 2014-15, higher seed yield of chickpea 1.27, 1.07 and 1.00 t ha^{-1} were recorded in T_2 at Moulvibazar and Sunamgonj, respectively.

Effect of fertilizer management on chilli+sweet gourd intercropping system

The experiment was conducted at Multilocation Testing site, Melandah, Jamalpur during the rabi season of 2014-15 to see the productivity and economic performance of fertilizer management of chilli+sweet gourd intercropping systems. The treatments were T_1= 100% sweet gourd (2 m × 2 m) + 40% chilli (50 cm × 100 cm) + 100% recommended fertilizer (RF) for chilli, T_2 = 100% sweet gourd (2 m × 2 m) + 40% chilli (50 cm × 100 cm) + 75% RF for chilli, T_3= 100% sweet gourd (2 m × 2 m) + 50% chilli (50 cm × 80 cm) + 100% RF for chilli. The treatments were tested in RCB design with 4 replications. The variety BARI Mistikumra-2 and local variety were used for sweet gourd and chilli, respectively. Sweet gourd seedling was transplanted in pit with 2m × 2m spacing and chilli seeds were sown in broadcast maintaining the percentage of seeds. Chilli was fertilized with 120-80-120-20-4 kg ha^{-1} NPKSZn and 5 t ha^{-1} cowdung. Half N and full amount of other fertilizer were applied as basal. Rest of N was applied in three equal split as ring dressing 20, 50 and 70 days after transplanting. On the other hand, before 10 days of sweet gourd transplanting 4 kg cowdung 50g TSP, 35g MOP was applied per pit as basal. At 10 DAT, 35g urea + 30 g MoP, at 30 and 50 DAT 35g urea and at 70 DAT 20 g urea were applied as ring dressing followed by irrigation. The seeds of chilli were sown on 1 October and seedlings of sweet gourd were planted on 16 November, 2014. Three hand weeding was done at 30, 50 and 70 DAP. Chilli was harvested on 10-22 February 2015. Sweet gourd was harvested on 15 March to 15 April 2015.Yield and yield attributes of sweet gourd was influenced significantly by fertilizer application in the intercropping systems. 25% reduction of fertilizer in chilli as in T_2 (100% sweet gourd+40% chilli +75% RF) significantly reduced yield of both sweet gourd and chilli but increasing population of chilli by 10% did not affect yield of sweet gourd but increased yield of chilli. The highest fruit yield (34.12 t ha^{-1}) of sweet gourd was found from T_3 and the lowest (27.98 t ha^{-1}) from T_2. The highest sweet gourd equivalent yield (96.12 t ha^{-1}) was obtained from T_3 which gave 29.49% higher yield advantage over T_2. The gross return (Tk. 3,84,480 ha^{-1}) and gross margin (Tk. 2,93,565 ha^{-1}) were also found the highest from 100% sweet gourd +50% chilli +100% RF (T_3).

Fertilizer management for Potato/Sweet Gourd-Maize T. Aman rice cropping pattern

The trial was conducted at Agricultural Research Station, OFRD, BARI, Alamnagar, Rangpur during the year of 2013-14 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. The variety BARI Alu 8, ACI, NK-40 and Binadhan-7 was used for potato, sweet gourd, maize and rice, respectively. The on station experiment was laid out in RCB design with 3 replications. In case of potato, the fertilizers except urea were applied as basal and the rest urea was applied during earthing up at 30 days after sowing of potato. In case of sweet gourd, all the fertilizers were applied as ring placement method after potato harvest followed by irrigation and zinc fertilizer was broadcasted singly. Urea was applied in maize in three equal splits viz. $^1/_3$ during final land preparation,$^1/_3$ after first weeding (6 leaves stage) and $^1/_3$ at 10 leaves stage. Yield of potato did not vary significantly due to different fertilizer packages applied. The highest yield of sweet gourd (22.57 t ha^{-1}) was recorded in T_2. The highest maize grain yield (7.90 t ha^{-1}) was recorded in T_2 which was statistically similar to that of T_5 (7.30 t ha^{-1}) and the lowest was recorded from T_1 (7.10 t ha^{-1}). In case of T. Aman rice, the highest grain yield was recorded in T_3 (4.55 t ha^{-1}) and the lowest in T_4 (4.19 t ha^{-1}). The highest gross return was estimated in the T_3 (Tk.538100 ha^{-1}) but the highest gross margin was obtained from T_5 (Tk.229195ha^{-1}).T_4 provided the lowest gross return (Tk.491990 ha^{-1}) and the lowest gross margin (Tk.194634 ha^{-1}). The highest benefit cost ratio was recorded in T_5 (1.78) and the lowest was obtained from T_4 (1.65).

Development of fertilizer recommendation for Lentil+Mustard-B.Aus-Blackgram cropping pattern in charland under AEZ-11

The experiment was conducted at charland of Charsadipur village of Pabna during the rabi season of 2013-14 to determine appropriate fertilizer dose for enhancing production and income fromLentil+Mustard-B.Aus-Black gram cropping pattern. Eight fertilizer packages such as: 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 on Lentil+Mustard-B.Aus-Blackgram cropping pattern. The variety BARI Masur 6, BARI Sarisha 14, BARI Mash-3 and Hashikalmi of lentil, mustard, black gram and B.Aus rice, respectively were selected for this study. The experiment was laid out in RCB design with three replications. The seeds of lentil and mustard were broadcasted in each plot on 10 November 2013 maintaining the same ratio of 80:20 for lentil+ mustard. Muustard and Lentil was harvested on 9 February and 23 February 2014, respectively. Soil test based 100% N-P-K-S-Zn (STB) + 25% NPK (T_6) demonstrated better performance on crop growth and yield of crops in lentil+mustard-B.aus-black gram cropping pattern in charland of Pabna. The maximum economic return in terms of gross return and gross margin was also recorded in the same fertilizer package (T_6).

Ffect of ash as a source of potassium and silica on the yield of wheat under heat stress environment

The experiment was carried out at FSRD site, Pushpopara, Pabna, and the Agricultural Research Station, Rajbari, Dinajpur during the Rabi season of 2014-15 to assess the effect of ash as a source of potassium and silica on the yield of wheat. There were six treatments viz; T_1= Recommended fertilizer dose, T_2= T_1+25% extra K, $T_3 = T_1$ +1.00 t ash ha^{-1}, $T_4 = T_1$ + 1.25 t ash ha^{-1}, $T_5 = T_1$ + 1.50 t ash ha^{-1}and T_6 =Control. The experiment was laid out in a RCB design with three replications. The wheat var. BARI Gom 26 was used in Pabna but BARI Gom 28 was used in Dinajpur. The unit plot size was 8 m × 5 m. The seeds were broadcasted on 03 December 2014 and 07 December2015 in Pabna and Dinajpur, respectively maintaining seeding rate of 120 kg ha^{-1}. To understand crop response to ash under heat stress, some traits such as chlorophyll in terms of SPAD value, canopy temperature, relative water content (RWC) was measured during growth stages. SPAD value was measured with SPAD meter (SPAD 502, Minolta, Japan) and canopy temperature was recorded with Infrared Thermometer. 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, 0.21 meq/100g 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/100g soil, 3.5 µg/g soil and 0.77 µg/g soil, respectively. Higher grain yield was obtained from all levels of ash plus RF followed by 25% K plus RF while lower yield from control. The highest yield was obtained from T_4 (4.34 t ha^{-1}) and T_3 (4.37 t ha^{-1}), respectively in Pabna and Dinajpur. T_6 (control) produced significantly lowest yield of wheat at both the locations. Flag leaf chlorophyll content (SPAD value) showed positive relationship with grain yield whereas canopy temperature showed negative relationship. In Pabna, maximum economic return in terms of gross return and gross margin was obtained from 1.25 t ash ha^{-1}plus RF (T_4) which was followed by 1.5 t ash ha^{-1} plus RF (T_5) but the highest gross return (Tk. 102740 ha^{-1}) and gross margin (Tk. 58700 ha^{-1}) were obtained from T_3 (T_1 +1.00 t ash ha^{-1}) in Dinajpur.

Response of hybrid maize to Boron fertilization

The experiment was carried out at MLT site of Kushtia Sadar under Kushtia district during the Rabi season of 2014-15 to determine optimum dose of B fertilizer in hybrid maize production and to increase yield and farmers' income. BARI Hybrid Maize 9 was tested in this study. The treatments were T_1 = 100% N-P-K-S-Zn 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}. The trial was laid out in RCB design with three replications. Unit plot size was 4 m x 5 m with spacing of 60 cm × 20 cm. The seeds were sown on 07 November 2014. The crop was irrigated in 5 times at 21, 39, 72, 91 and

114 DAS. The crop was harvested at 10 April 2015. The maximum grain yield (8.77 t ha^{-1}) was obtained from T_6 (T_1 + 2.5 kg ha^{-1} B) followed by T_5 and T_4 and the lowest grain yield (7.83 t ha^{-1}) was found in T_1 (100% N-P-K-S-Zn and cowdung 5 t ha^{-1} + 0 kg ha^{-1} B). The yield was the highest in T_6 treatment due to its higher no. of grain per cob and 100 grain weight. The highest gross return (Tk. 150850 ha^{-1}) and gross margin (Tk. 74869 ha^{-1}) were obtained from $T_6 = T_1$ + 2.5 kg ha^{-1} B. Similar trend was found in the results. However, the highest MBCR (33.91) was obtained from T_2 indicating that it is profitable compared to other treatments.

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 the year of 2014-15 to find out the appropriate fertilizer dose and placement technique of fertilizer under zero tillage maize cultivation. Different treatments viz.T_1= Recommended dose (350-55-80-35-2-2 kg, N-P-K-S-B ha^{-1}) + Broadcast application, T_2= T_1 + 10% extra fertilizer in broadcast, T_3= Recommended dose (350-55-80-35-2-2 kg,N-P-K-S-B ha^{-1}) + Furrow placement, T_4= T_3 + 10% extra fertilizer with furrow placement and T_5= Farmers' practice were tested on maize (variety BARI Hybrid Maize 9). The experiment was laid out in RCB design with three replications. Broadcast technique was followed for fertilizer application in T_1, T_2 and T_5 whereas fertilizers were applied in furrow in T_3 and T_4. The unit plot size was 24 m^2. The seeds were sown on 19th November 2014 through dibbling method. The crop was harvested on 27 April 2015. Recommended dose of fertilizer (RF) produced significantly higher maize grain yield compared to farmer's practice under zero tillage condition. Fertilizer application technique did not make any remarkable effect on grain yield. However, higher gross return and gross margin was obtained from RF plus broadcast application.

Integrated nutrient management for watermelon in the charland of Bhola

The experiment was conducted at MLT site, Charfashion, Bhola under OFRD, Bhola duringthe Rabi season of 2014-15. Five different nutrient packages viz. T_1: soil test based (STB) fertilizer for high yield goal, T_2: integrated plant nutrient system (IPNS) with 5 tha^{-1} cowdung considering T_1, T_3: 25% higher fertilizer than T_1, T_4: T_1 + 50% higher K & Zn and T_5: Farmers' practice were tested to know the effect of integration of nutrients and to find out the optimum and economic fertilizer dosefor water melon cultivation in charland.Hybrid variety Glory was used. Unit plot size was 6m × 8m. Seeds were sown in pits maintaining pit to pit spacing 2m × 2 m. Harvesting was done on 09-15 April 2015. Average soil test value was N = 0.093% (low), P = 3.1 µg g^{-1} soil (very low), K = 0.29 meq 100g^{-1} soil (optimum), S = 134 µg g^{-1} soil (very high), Zn = 0.61 µg g^{-1} soil (low), B = 0.33 µg g^{-1} soil (medium).Vine length, fruit circumference and marketable fruit yield differed significantly due to different nutrient packages. Soil test based IPNS approach gave the highest fruit yield (49.58 t ha^{-1}). Farmers used very high amount and imbalanced fertilizer that produced much lower fruit yield as compared to STB and IPNS approach. Total variable cost (TVC) was highest in farmers' practice as farmers used very high quantity of chemical fertilizer for water melon in Bhola. IPNS approach produced the highest gross margin (Tk. 232813 ha^{-1}) due to higher fruit yield and good size and shape.

Integrated nutrient management for growing watermelon in saline and coastal area of Patuakhali

The experiment was conducted at MLT site, Kuakata, Patuakhali and MLT site Amtali, Barguna during Rabi season of 2014-15 to determine appropriate doses of fertilizer for watermelon production in coastal area. Four fertilizer doses: T_1: Soil test based inorganic dose for high yield (FRG, 2012), T_2: IPNS approach with 5 t ha^{-1} cowdung, T_3: Upzilla Nirdeshika dose, N_{83} P_{28} K_{41} S_{16} kg ha^{-1}, and T_4: Farmers' practice (av. of 20 farmers) were tested.The experiment was laid out in RCB design with six dispersed replications. The experiment was laid out in RCB design with six dispersed replications having unit plot size 8m × 5m. Spacing was 3 m × 2 m and the water melon var. Asian-2 was used in the experiment. Seeds were sown at Amtali on 18 December 2014 and 24 December 2014 at Kuakata and harvesting started from 10 April 15 (113-118 DAS) in both the locations. Integrated Plant Nutrient System (IPNS) approach was found better than other treatments. IPNS based dose produced the highest fruit yield (48.30 t ha^{-1} in Amtali and 38.8 t ha^{-1}` in Kuakata) and higher benefit cost ratio. Lower yield was obtained from T_3 (Upazilla Nirdeshika based dose) treatment in both the locations.

Effect of liming on cabbage and tomato production in acidic soil

The experiments were conducted to find out the optimum dose of lime for maximum yield of cabbage and tomato at farmer's field of Bhaluka, Mymensingh during the rabi season of 2014-15. The experiments were laid out in RCB design with three dispersed replications. Three levels of limes viz.1.0, 2.0 and 3.0 t ha^{-1} were tested with recommended doses of fertilizer along with 5 t ha^{-1} cowdung. Soil samples from top soil (0-15 cm depth) of the experimental plots were collected before applying lime and after the harvest of the vegetables crop. The varieties of those chosen crops were Atlas-70 for cabbage and BARI tomato 7 for tomato. The cabbage and tomato were sown on 12 November 2014 and harvested on 05 to 13 February and 02 February to 03 March 2015, respectively. The unit plot size was 4m × 3m with the spacing 60cm × 50cm and 60cm × 40cm, respectively. Liming application has significant effect on cabbage and tomato yield, which varied between 77.93 to 83.70 t $ha^{-1}$and 70.52 to 87.31 t ha^{-1}, respectively. Highest significant cabbage and tomato yield of 83.70 and 87.31t ha^{-1} respectively were obtained with the rate of 2.0 t ha^{-1} of lime. The yield of cabbage and tomato increased with increased rate of lime up to 2.0 t ha^{-1} and thereafter it declined at 3.0 t ha^{-1}. Considering cost and return analysis the same treatment of 2.0 t ha^{-1} lime also showed the maximum gross return (Tk. 8,37,000 and 8,73,100 ha^{-1}) and gross margin (Tk. 5,95,000 and 6,32,100 ha^{-1}) from cabbage and tomato, rspectively.

Effect of organic compost in combination with chemical fertilizer on the yield of tomato in charland of Jamalpur

An experiment was carried out at the multi-location testing site, Malancha, Melandah, Jamalpur during November, 2014 to March, 2015 to known the effect of vermicompost and kitchen waste compost on winter tomato. 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} +2/3rd RD, T_3= Kitchen waste 3 t ha^{-1} +2/3rd RD and T_4= Farmers' practice were used in the study. RCB design was followed with three replications for the experiment. The seeds of BARI Tomato 14 were sown in the seed bed on 10 October 2014. Seedlings were transplanted in the main field on 19 November 2014. 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. Application of organic compost significantly influenced the yield and yield attributes of tomato in the charland. Treatments having organic compost along with 2/3rd 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} +2/3rd RD) was most profitable as provided the highest gross return (Tk. 612010 ha^{-1}) and gross margin (Tk. 505230).

Effect of liming on the yield of different vegetables grown in acidic soil of Sylhet

A field experiment was carried out in 2013-15 at the farmer's field having acidic clay loam soil at farming system research and development (FSRD) site, Jalalpur and multilocation (MLT) sites, Moulvibazar and Zokigonj. Two factors experiments viz. A) Fertilizer management, M_1: Soil test based (STB) fertilizer recommendation and M_2: Farmers' practice (FP) and B) Level of limes viz. L_1: 0 t ha^{-1}, L_2: 1 t ha^{-1} and L_3: 2 t ha^{-1} were considered as treatments. These were tested on four vegetable crops viz. potato, cabbage, cauliflower and tomato. Trials were laid out in split-plot design with six dispersed replications, where fertilizer management was allotted to main plot and level of limes were distributed in the sub-plots. The amendments of different levels of lime were applied on 3-5 November and were incorporated into the soil by ploughing. Yields of potato, cabbage, cauliflower, and tomato were varied significantly with treatments and locations. The mean yields of potato, cabbage, cauliflower, and tomato (18.45, 63.79, 49.94 and 57.40 t ha^{-1}, respectively) were recorded higher in STB fertilizer management than FP. Application of lime @ 1 t ha^{-1} (L_2) was significantly influenced the yields of all vegetables. The highest mean yields of potato, cabbage, cauliflower, and tomato were recorded in L_2 treatment (19.18, 65.17, 49.23 and 60.29 t ha^{-1}, respectively) that was followed by L_3. Combined effect of fertilizer management and level of liming showed that the treatment combination M_1L_2 produced the highest mean yields of potato, cabbage, cauliflower, and tomato 20.09, 69.10, 54.24 and 62.87 t ha^{-1}, respectively. Application of lime might have raised the pH of the acidic soils towards neutral and made nitrogen and phosphorus more available to plants that helped increase the yield of crops. Higher gross returnand gross margin (tk. 3was also obtained from the combined effect of STB fertilizer management and soil amendment with lime 1 t ha^{-1} (M_1L_2).

Influence of organic and inorganic fertilizer on garlic

The experiment was conducted in the farmers' field of Trishal, Mymensingh during the Rabi season of 2014-15 to evaluate the effect of nutrients on garlic and to find out the optimum fertilizer dose for garlic production. The experiment was laid out in RCB design. There were six fertilizer doses as: T_1= Recommended fertilizer dose for HYG ($N_{100}P_{48}K_{80}S_{30}$ kg ha^{-1} with 5 t ha^{-1} cowdung), T_2= T_1 + 5 t ha^{-1} cowdung, T_3 = T_1 + 1.5 t ha^{-1} vermicompost, T_4= STB ($N_{90}P_{42}K_{72}S_{20}$ kg ha^{-1}) + 5 t ha^{-1} cowdung, T_5 = STB ($N_{90}P_{42}K_{72}S_{20}$ kg ha^{-1}) + 1.5 t ha^{-1} vermicompost and T_6= Farmers' practice. Garlic variety BARI Rashun-2 was used for the trial. Unit plot size was 3m × 3m. Seed cloves were planted at a spacing of 15 cm × 10 cm on 15-16 November 2014. The bulb harvesting was done on 20-22 March 2015. Among the treatments, the highest bulb yield (8.64 t ha^{-1}) was obtained from the T_5 (STB + 1.5 t ha^{-1} vermicompost) which was statistically identical to T_3 treatment (T_1 + 1.5 t ha^{-1} vermicompost) followed by T_4. Treatments T_1 and T_2 produced identical yield which were significantly lower than T_5 and T_3 but significantly higher than T_6. Results indicate that organic manure played significant role in increasing yield of garlic. Between two sources of organic manure, vermicompost performed better for yield maximization of garlic.Cost and return analysis of different nutrient management packages are presented in Table 3. Gross return (Tk. 432000 ha^{-1}) and gross margin (Tk. 271260 ha^{-1}) were highest in T_5 that received 1.5 t ha^{-1} vermicompost with STB and the lowest in farmers' practice.

Effect of liming on the production of turmeric

The field experiments were conducted at farmer's field of Phulbaria, Mymensingh to find out the optimum dose of lime for maximum yield of turmeric during the year of 2014-15. Four levels of limes viz. 0.5, 1.0, 1.5 and 2.0 t ha^{-1} with control treatment were tested along with recommended doses of fertilizer. The experiments were laid out in RCB design with six dispersed replications. BARI Halud 4 was used in this experiment. The unit plot size was 4m × 5m 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 the vegetables crop and chemical properties of soils. Turmeric seeds (rhizomes) were transplanted on 10-12 January 2014 and harvested on 8-10 February 2015, respectively. The amounts of different levels of limes were done 15 days prior to crop sowing and incorporated into the soil by ploughing. Liming application has significant effect on turmeric yield.

The highest yield of turmeric (24.0 t ha^{-1}) and gross margin (Tk.200660 ha^{-1}) was obtained from lime application @ 1.0 t ha^{-1} and the lowest yield (18.7 t ha^{-1}) and gross margin (Tk.129160 ha^{-1}) was found in control treatment (without lime).

Fertilizer and water management of chilli in coastal region

The experiment was conducted at MLT site, Daulatkhan, Bhola during late Rabi season of 2014-15 under AEZ-18. Three treatments viz., T_1= Soil test based fertilizer dose for high yield goal (HYG) (FRG-2012) + Two irrigation at 25 and 40 days after transplanting (DAT), T_2= Soil test based fertilizer dose for HYG (FRG-2012) + Three irrigation at 25, 40 and 60 DAT and T_3= Farmers' practice (Surveyed) were tested to find out an optimum fertilizer dose and irrigation frequency for higher yield of chilli. Soil test based fertilizer dose for high yield goal was 82-47-34-1 kg, N-P-K-Zn ha^{-1} for treatment T_1 and T_2.Fertilizer dose for farmers' practice was 56-31-26 kg of N-P-K. ha^{-1}. Most of the farmers used local chili varieties and do not irrigate their chilli fields. The unit plot size was 8 m × 5 m. Spacing was 60 cm × 40 cm. Thirty eight days old seedlingwas transplanted on 12 January 2015. Ripen chilli was harvested from 20 April to 12 May 2015. Average soil nutrient status of the experimental plots was as follows: pH- 7.4 (slightly alkaline), OM- 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). Treatment T_2 produced the highest green (8.92 t ha^{-1}) and dry chilli yield (2.23 t ha^{-1}) which was statistically identical to that of T_1. The highest gross return (Tk. 223100 ha^{-1}) and gross margin (Tk. 137570 ha^{-1}) was obtained from T_2.

[1]**Response of lentil to Zinc and Boron in charland**

The effect of different combinations of Zinc (Zn) and Boron (B) on growth and yield of lentil was studied at charland area,Charsadipur,Pabna under AEZ-11 during Rabi season of 2014-15 to seethe response and find out optimum dose of Zn and B for growing lentil in the charland. The experiment was consisted of four treatmentssuch as: T_1= Recommended fertilizer dose (FRG'12), T_2= T_1+1 kg B ha^{-1}, T_3= T_1+3 kg Zn ha^{-1} and T_4= T_1+1kg B+3 kg Zn ha^{-1}. The experiment was laid out in RCB design maintaining three replications. The variety of lentil was BARI Masur 6.The seed of lentil was broadcasted in each plot on 06 November 2014. Weeding was done once at vegetative stage for better growth of the crops. The soil texture of the land was sandy. The pH, organic matter, total N, available P, K, S and Zn were 8.1, 0.82%, 0.05%, 13.30 μgg $soil^{-1}$, 0.32 meq 100g $soil^{-1}$, 9.2 μg g $soil^{-1}$ and 0.57 μgg$soil^{-1}$, respectively.Dry matter production per plant was lower at different growth stages i.e. before flowering, 80%flowering and maturity stages with low level of B (T_1). Additional 1.0 kg B ha^{-1}(T_2) remarkably increased dry matter at all growth stages. Additional 3.0 kg Zn ha^{-1}(T_3) and also additional Znwith additionalB(T_4)increased dry matter production of lentil but lower than additional B only. Performance of yield attributes of lentil found better with recommended fertilizer plus 1.0 kg B ha^{-1}(T_2) that produced significantly highest seed yield (1.40 tha^{-1}) which was statistically at par with T_4(1.36 t ha^{-1}). Additional 3 kg of Zn ha^{-1}(T_3) and additional Zn with additional B (T_4) produced statistically similar seed yield but significantly higher than T_1(1.03 tha^{-1}). In terms of economic return,maximum gross margin(Tk.52230 ha^{-1}) was obtained from T_2 and minimum (Tk.25650 ha^{-1}) from T_1.

Effect of seed priming in Zinc solutions on chickpea varieties in High Barind Tract

The trial was carried out at farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during 2014-15 to find out the optimum zinc concentration for seed priming of chickpea to grow in the High Barind Tract. There were five treatments with two chickpea varieties. The experiment was laid out in RCB design with three replications. The treatments were viz. T_1=Dry seed, T_2= Water primed,

T_3=0.025% of Zn solution, T_4= 0.05% of Zn solution and T_5=0.075% of Zn solution. The seeds of chickpea (varieties BARI Chola 5 and BARI Chola 9) were primed for 12 hours with water, and 0.025%, 0.05 %, 0.075% Zn solutions as per treatment specification. The soil of the experimental plots belongs to Amnura series under AEZ 26 and composed of grey terrace soils of silty loam to silty clay loam in texture with a pHvalue of 5.9. The soil contained 0.89% organic matter, 0.08% total N, 8 ppm available P, 0.23 mq% exchangeable K, 15 ppm available S, 0.1 ppm available B and 1.2 ppm available Zn. Dry seed (non-primed) was used as a control treatment. Seed was sown on 13 November 2014 with the help of hand hoe at a seed rate of 45 kg ha^{-1}. A plot size of 4 m × 5 m with rows distance of 30 cm was used. Chickpea was harvested on 16 March 2015. Seed primed with 0.05% Zn solution resulted in the highest seed yield of chickpea for both the varieties. Consequently, the maximum gross return and, gross margin were obtained from priming with 0.05% Zn solution (T_4) followed by 0.075% Zn solution (T_5) with both the varieties BARI Chickpea 5 and BARI Chickpea 9. It might be concluded that seed priming with 0.05-0.075% Zn solution improves grain yield of chickpea.

Response of mustard to soil test based fertilizer management

A field experiment was carried out at Sonapur of Muradnagar upazilla in Comilla district under Debidwar MLT site during the Rabi season of 2014-15. The experiment was conducted in the Old Meghna Estuarine Floodplain (AEZ-19) soil to find out the optimum and economic fertilizer dose for higher yield of mustard and also to update location specific fertilizer recommendation. The experiment was laid out in RCB designwith three replications and 6 treatments. The treatments were T_1= Soil Test Based (STB) fertilizer dose (FRG-2012), T_2= T_1+ 15% STB, T_3= T_1+ 30% STB, T_4= 80% STB from inorganic fertilizer + 20% STB from cowdung/poultry manure, T_5= Farmers' Practice and T_6= Control. The unit plot size was 4 m ×3 m. Row to row distance was 30 cm and seeds of BARI Sarisha 14 were sown continuously on 11 November 2014. The crop was harvested at 75 days after sowing. Seed yields were taken from the whole plot. Among the treatments, T_4 gave the maximum seed yield (1385.56 kg ha^{-1}) which was at par with T_1, T_3 andT_2. The lowest seed yield (450.20 kg ha^{-1}) was obtained from T_6 (Control).

Effect of fertilizer management on flower yield of gladiolus

The experiment was conducted at MLT site Jhikargacha, Jessore during Rabi season of 2014-15 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 dose, T_3= T_1+ 25% NPKSZnB of STB and T_4 = Farmers' practice (N-P-K-S-Zn-B @ 155-75-95-48-5.50-1 t ha^{-1} and cowdung 10 t ha^{-1}). The 100% NPKSZnB (STB) was 172-36-93-28-1-0.5 kgha^{-1}. The experiment was laid out in a RCB design with three replications. The 100% NPKSZnB (STB) was 172-36-93-28-1- 0.5 kg ha^{-1}. Gladiolus local was used as test crop. The unit plots size was 3m x 2 m. The crop was harvested on 16-19 February 2015. The highest plant height (94.17 cm) and number of leaves/plant (10.33) were observed in T_1. Similarly, the maximum length of rachis (43.07 cm) and number of florets/spike (12.67) were also found from the same treatment followed by T_2 and T_3 and these were lowest in farmers' practice.

Integrated nutrient management for maize and mango in agroforestry system to cope with climate change

The experiment was carried out at FSRD site, Pushpopara, Pabna during 2014-15 cropping season to know the effect of integrated nutrient management on the performance of maize and mango under mango based agroforestry system.The experiment comprised of three different treatments viz. T_1: Recom. dose (255-75-80-52-2-1.5-0 kg, N-P-K-S-Zn-B-Cowdung (CD) ha^{-1}), T_2: IPNS (232-68-55-52-2-1.5-5000 kg, N-P-K-S-Zn-B-CD ha^{-1}) and T_3: Farmers practice-FP (346-57-142-45-0-0-10000 kg, N-P-K-S-Zn-B-CD ha^{-1}) for maize. The experiment was laid out in RCB designwith three replications. Maize variety NK-40 was planted in Mango (var. Amropali) garden as agroforestry system on 02 December 2014. The unit plot size was 60 m^2. The crop was harvested on 04 April 2015. Crop growth rate (CGR) was measured at vegetative period and reproductive periods from whole plant dry matter collected at different time. Chlorophyll was measured every week by SPAD meter started from silking stage. Mango was harvested plot-wise after maturity and converted in hectare. Treatment-wise mango TSS was measured from fully ripened mango with a brix meter. Light energy interception and CO_2 sequestration was calculated dry matter basis. Higher crop growth rate at vegetative stage was enhanced early tasseling and silking in IPNS and FP treatments. Higher grain number per cob and grain weight was also contributed by IPNS and FP treatments, which contributed more maize grain yield. Mango yield and mango equivalent yield was also observed higher in both FP and IPNS treatment. Inversely, the TSS of mango was lower in FP but higher in IPNS and Recom. treatment. A positive and highly significant relationship was observed between chlorophyll content and CGR, CGR and light energy interception (LI), LI and grain yield, chlorophyll content and CO_2 sequestration, and CO_2 sequestration and grain yield of maize. Maximum gross return and gross margin was calculated from FP and IPNS treatment, respectively.

Effect of tillage and residue management in soil moisture retention and productivity of chickpea-Maize T. Aman rice cropping pattern in Barind soil

The field trial was conducted at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during 2013-14 with an objective to see the effects of tillage and residue management on soil moisture conservation and performance of the crops under Chickpea Maize T. Aman rice cropping pattern in the High Barind Tract. The experiment was conducted in split plot design with three replications. There were three tillage options viz. (i) ST= strip tillage (ii) Bed=bed planting and (iii) CT= conventional tillage; and three crop residue managements, viz. (i) R_0= No residue (ii) R_1=15% residue (iii) R_2=30% residue retention in the study. BARI Chola 9, BARI Hybrid Maize 9 and BRRI dhan 57 were used for chickpea, maize and T. Aman rice, respectively as a test crop in the study. The unit plot size was 5 m × 4 m. Seeds of chickpea were sown in line maintaining a spacing of 30 cm with continuous sowing at 15 November 2013. The seeds of maize were sown with maintaining 60 cm × 25 cm spacing on 16 March 2014. Rice was transplanted on 12 August maintaining 20 cm × 15 cm of spacing. Soil moisture regimes of the experimental plots were recorded at a depth of 0-15cm at 15-days intervals. The crops were harvested on 12 March 2014, 08 August 2014 and 08 November 2014 for chickpea, maize and T. Aman, respectively. The Bed planting system gave the highest yields of chickpea (1.23 t ha^{-1}), maize (5.89 t ha^{-1}) and rice (3.98 t ha^{-1}) and followed by ST and lowest in CT. Among the residue management, 15% residue retention showed the highest yields of chickpea (1.17 t ha^{-1}), maize (5.71 t ha^{-1}) and rice (3.92 t ha^{-1}). The Bed plating system also gave the highest rice equivalent yield (REY) (12.97 t ha^{-1}), gross margin (Tk. 122660 ha^{-1}) and benefit cost ratio (BCR) 2.10 followed by ST. In case of residue management, 15% residue retention gave the highest REY (12.48 t ha^{-1}), gross margin (Tk. 112317 ha^{-1}) and BCR (2). The results indicate that, bed planting coupled with 15% residue retention and strip tillage with 15% residue retention might be a good option for higher yield, moisture retention and economic return for Chickpea Maize T. Aman rice cropping pattern in High Barind Tract of Bangladesh.

Effect of raised bed planting and potassium application on the mitigation of soil salinity and yield of maize

A field experiment on hybrid maize was conducted in coastal saline at Kuakata, Patuakhali under Ganges Tidal Floodplain (AEZ 13) during Rabi 2014-15 to know the effects of planting method and K fertilization interactions on maize yield, nutrient uptake and K dynamics in soil under salt stress condition. Four rates of K fertilizer (native K, 100% STB K, 125% STB K and 150% STB K) were tested under two planting methods (Flat land and raised bed) in a RCB design with three replications. Other nutrients were also applied following STB method. Prior to seed sowing the salinity level was low (EC: 2.58 to 2.74 ds m^{-1}) but increased gradually the progress of growing period and reached at the peak in April (EC: 12.16 and 12.46 ds m^{-1} for flat land and raised bed plot, respectively). Potassium dose was estimated based on the soil test value as 54, 67.5 and 80.34 kg K ha^{-1}. The plot size was 4m × 5m for both raised bed and flat land. The seeds of hybrid maize (cv. BHM- 9) were sown on 27 November 2014 maintaining a spacing of row to row 75 cm and seed to seed 25 cm. Soil salinity was monitored at 15 days interval staring from sowing to harvest. The crop was harvested in its maturity on 12 April 2014. Higher rates of K contributed to 23-29% increased yield over control as against 14% with STB dose which implies the necessity of higher dose of K in salt affected soils in augmenting yield. The flat land method of cultivation gave 8.07 t ha^{-1} grain yield, which increased to 8.30 t ha^{-1} for raised bed method contributing to only 2.6% yield benefit. Application of 25-50% higher rates of K over present STB dose preferably under raised bed method of cultivation could be useful in minimizing salt stress and optimizing the yield of hybrid maize in the study area.

Response of chickpea varieties to elite strains of *rhizobium*in High Barind Tract

The field experiment was carried out during Rabiseason of 2014-15 at Farming System Research and Development (FSRD) Site, Kadamshahar, Godagari, Rajshahi (AEZ 26) with a view to assess the effect of Rhizobium inoculation on four varieties/lines of chickpea viz., BARI Chola 5, BARI Chola 9, ICCV-92944 and ICCV-92954. The treatments were designed in RCB having three replications. Each variety/line was tested with and without Rhizobium inoculation. Rhizobial inoculum (Rhizobium strain RCa-220) @ 1.5 $kgha^{-1}$ was used for seed inoculation. The unit plot size was 4m × 5m. 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^{-1} was used for inoculation treatment. The *Rhizobjum* 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 17 November 2014. Crops were harvested on 27 March 2015. 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, seed yield and stover yield, while the highest nodule number was obtained from ICCV-92944.

Use of vermicompost for improving the yield and nutritional quality of cabbage

The on-station experiment was conducted at On Farm Research Division, BARI, Rangpur during the Rabi season of 2014-15 to know the effect of vermicompost on the growth, yield and nutritional quality of cabbage. The experiment was laid out RCB design with three replications The experiment consisted of seven treatments viz, T_1=100% recommended chemical fertilizer (RCF), T_2=80% RCF, T_3=60% RCF, T_4=100% RCF+ VC (Vermicpompost) @ 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. The unit plot size 3m × 3m and spacing was 60 cm × 50 cm. Autumn queen variety seedling of thirty days was transplanted during 26 November 2014. Crop harvesting was started in 15 February and till 11 March 2015 was continued. Recommended dose of fertilizer for the crop was 240-35-60-30-1 kg ha^{-1} of N-P-K-S-B.The highest head yield was recorded in T_4 (59.21 tha^{-1}) and the lowest in T_7 (27.11 tha^{-1}) and as such the highest gross margin (Tk.176050 ha^{-1}) and the lowest (Tk.89960 ha^{-1}) was recorded in T_4 and T_7, respectively.

Improvement of Cropping Systems

Cropping pattern study for increasing cropping intensity and productivity in rice based cropping system in Rangpur

The experiment was conducted at On-Farm Research Division, Alamnagar, Rangpur with a view to increase cropping intensity and productivity through crop intensification in rice based cropping systems during 2013-14. There were three alternate patterns viz; FA_1=T. Aman(Binadhan-7)-Mustard (BARI Sarisha 14)–Boro (BRRI dhan28)–T. Aus (Parija); FA_2=T. Aman(Binadhan-7)-Potato (Granola)-Boro (BRRI dhan28)-T. Aus (Parija); FA_3=T. Aman(Binadhan-7)-Mustard (BARI Sarisha 15)-Mungbean (BARI Mung-6)-T. Aus (Parija) and one existing pattern F= T. Aman (BR11)–Fallow-Boro (BRRI dhan28)–Fallow. The experiment was laid out in RCB design. Cultivation of alternate cropping patterns (four crops) could be more profitable than that of existing pattern. Among alternate cropping patterns, T. Aman (Binadhan-7)-Potato (Granola)-Boro rice (BRRI dhan28)-T. Aus (Parija) was more profitable compared to other patterns. Thus cultivation of alternate cropping patterns would help to increase total productivity, farmer's income, employment and livelihood improvement.

Development of alternate cropping pattern Onion/Mungbean-Jute-T. Aman against onion-jute-T. Aman in the stable charland of Kurigram

The experiment was conducted at the farmers' field during 2013-14 to observe the performance of alternate cropping pattern (Onion/Mungbean-Jute-T. Aman rice) against existing cropping pattern (Onion-Jute-T. Aman rice) at char land in Ulipur, Kurigram. There were two treatments viz., F= Existing cropping pattern (Onion-Jute-T. Aman rice), AP= Alternate cropping pattern (Onion/ Mungbean- Jute-T. Aman rice). The alternate cropping pattern gave higher rice equivalent yield (27.85 t ha^{-1}) than that of existing one (20.33 t ha^{-1}). Gross return as well as gross margin were higher (Tk.127519 $ha^{-1}$and Tk.56769ha^{-1}, respectively) in alternate pattern over existing pattern.

Development of alternate cropping pattern Potato–Mungbean–Jute–T. Aman against Potato–Jute–T. Aman rice

The experiment was conducted in the farmers' field during 2013-14 to observe the performance of alternate cropping pattern Potato-Mungbean-Jute-T. Aman against existing cropping pattern Fallow-Boro-T. Aman rice in the MLT site Domar, Nilphamari. In developed pattern, the yield of potato, mungbean, T. Aus and T. Aman rice were 24.32, 0.54, 1.2 and 4.34 t ha^{-1} whereas in existing pattern, the yield of Boro and T. Aman rice were 4.90 and 4.55 t ha^{-1} , respectively. The alternate cropping pattern gave higher rice equivalent yield (25.03 t ha^{-1}) than that of existing one (9.45 t ha^{-1}). Gross return (Tk.406777 ha^{-1}) as well as gross margin (Tk.1162338 ha^{-1} were higher in alternate pattern against existing pattern. **G**ross return was higher by Tk.253215 ha^{-1} and gross margin by Tk.108476 ha^{-1} in alternate pattern over existing pattern.

Development of alternate cropping pattern Potato/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, Pirgonj (drought prone area), Rangpur during 2013-14 to evaluate the performance of Potato/Mukhikachu-T. Aman against Potato-Boro-T. Aman rice for saving water and increase profit. In the developed cropping pattern, yields of potato, aroid and T. Aman were 23.73, 18.46 and 4.87t ha^{-1}, respectively. In the existing cropping pattern, yields of potato, boro and T. Aman rice were 19.65, 4.21and 4.59 t ha^{-1}, respectively. The alternate cropping pattern gave higher rice equivalent yield (30.10 t ha^{-1}) than that of existing one (20.94 t ha^{-1}). Gross return and gross margin were higher in developed cropping pattern over existing one.

Development of alternate cropping pattern Potato/Sweet gourd-T. Aus-T. Aman in the stable charland of Kurigram district

The experiment was conducted in the farmers' field during 2013-14 to observe the performance of alternate cropping pattern Potato/Sweet gourd-T. Aus-T. Aman against existing cropping pattern Fallow-Boro-T. Aman rice at char land in Ulipur, Kurigram. The experiment was laid out in RCB design with 6 dispersed replications. Potato variety BARI Alu 25, Sweet gourd variety Local and T.

Aus rice variety Parija and T. Aman rice variety BRRI dhan 49, Boro variety BRRI dhan28 were used in the trial. The alternate cropping pattern gave higher rice equivalent yield (24.4 t ha^{-1}) than that of exsting one (9.46 t ha^{-1}). Gross return (Tk.395502ha^{-1}) as well as gross margin (Tk.126892ha^{-1}) were higher in alternate pattern) over existing pattern (Tk.153563 ha^{-1} and Tk.47663 ha^{-1}).

Development of alternate cropping pattern of Mustard-Mungbean-T. Aman in coastal area of Khulna

A field experiment was conducted at the MLT site, Bagerhat, during 2014-15 to improve existing cropping pattern by introducing new crops/crop varieties for higher yield and economic returns of the farmers. The alternatecropping pattern Mustard-Mungbean-T. Amanwas tested against the existing farmers' pattern Fallow-Fallow-T. Aman. Higher grain yield (4.23 t ha^{-1}) was obtained from Binadhan-7 compared to BRRI dhan30 (3.56 t ha^{-1}). In improved pattern, the yield of mustard (BARI Sarisha 14) and mungbean (BARI Mung-6) were observed as 1.20 and 1.37 t ha^{-1}, respectively. The improved cropping pattern gave the higher rice equivalent yield (11.36 t ha^{-1}) and gross margin (Tk.96175 ha^{-1}) while rice equivalent yield and gross margin in existing one were 3.56 t ha^{-1} and Tk. 36130 ha^{-1}, respectively.

Development of alternate cropping pattern of Mustard-Jute-T. Aman in coastal area of Satkhira

The experiment was conducted at the MLT site, Satkhira during 2014-15 to develop an improved cropping pattern against the farmers' existing one. The experiment was laid out in RCB design with four dispersed replications. The alternate cropping pattern Mustard-Jute-T. Aman was tested against the farmers existing cropping pattern Fallow-Fallow-T. Aman. Higher grain yield of rice (4.70 t ha^{-1}) was obtained from Binadhan-7 than that of local variety of rice Jamaibabu (3.95 t ha^{-1}). In improved cropping pattern (ICP), the yield of mustard (BARI Sarisha 14) and jute (O-9897) were observed as 2.01 and 2.15 t ha^{-1}, respectively. The ICP recorded higher rice equivalent yield (13.27 t ha^{-1}) than existing one (3.95 t ha^{-1}). The ICP also gave the higher gross margin (Tk. 142637 ha^{-1}) compared to existing cropping pattern (Tk. 5934 ha^{-1}).

Development of alternate cropping pattern Potato/Maize-T. Aman rice against Maize-fallow–T. Aman rice

A field trial was conducted at the farmers' field of Sherpur MLT Site (AEZ 4), Bogra during 2013-14 to fit potato in the Maize Fallow-T. Aman cropping pattern and to increase cropping intensity. There were two treatments i.e, Existing cropping pattern Maize Fallow-T. Aman rice and alternate cropping pattern Potato/Maize T. Aman rice. Seeds of maize were sown as a relay after 30 days of potato planting in Potato/Maize T. Aman rice cropping pattern. The unit plot size was 12m x 10m. Potato (var. BARI Alu 8) were planted on 28-30 November 2013 at 60 cm × 25 cm spacing. Maize (exotic var. Decalb-981) were sown as a relay 30 days after potato planting on 28-31 December 2013 in alternate cropping pattern whereas in existing pattern maize seeds were sown in line on 22 November-06 December 2013. Potato was harvested on 22 February to 05 March, 2014. Sole maize was harvested on 1-11May 2014 and maize in alternate cropping pattern was harvested on 25 May-03 June 2014. In T. Aman rice, thirty days old seedlings (BRRI dhan 49) were transplanted on 5-15 August 2014 at 20cm×15cm spacing. The crop was harvested on 18-24 November 2014. Higher rice equivalent yield (REY) was found in alternate cropping pattern (23.79 t $ha^{-1}yr^{-1}$). Consequently higher gross return (Tk. 482390 ha^{-1}) and gross margin (Tk. 261665 ha^{-1}) was recorded from the alternate cropping pattern over existing cropping pattern due to additional yield of potato.

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 existing cropping pattern Wheat- Jute-T. Aman by introducing improved crop varieties in the farmer's existing pattern. There were two treatments i.e Existing Cropping pattern: Wheat (BARI Gom 24)-Jute (Local/Indian)-T. Aman (Guti Sharna) and Improved Cropping pattern: Wheat (BARI Gom 26)-Jute (O-9897)-T. Aman (BRRI dhan49). Higher yield and gross return were obtained from improvedcropping pattern over existing cropping pattern due to introduction of new varieties.

Development of alternate cropping pattern Mustard-Boro-T. Aus-T. Aman against Mustard-Boro-T. Aman rice cropping pattern

The experiment was conducted at Gabtoli, Bogra (AEZ 3) during November 2013–October 2014 to increase cropping intensity and productivity. Four crops based cropping sequences were compared in the study. The treatments were Mustard–Boro–T. Aus-T. Aman (FA) and Mustard–Boro–Fallow-T. Aman (F). The highest rice equivalent yield (16.43 t ha^{-1}) was recorded from FA. Inclusion of T. Aus and modern variety of mustard in FA increased rice equivalent yield 39.24% compared to F.

Developmentof alternate cropping pattern Boro–T. Aus- T. Aman rice against Boro-Fallow-T. Aman

A trial was conducted for three consecutive years at the MLT site, Kushtia during 2011-12 to 2014-15 to improve the existing cropping pattern and to increase yield and farmers income. The experiment was laid out in RCB design with six replications. Alternate cropping pattern Boro (BRRI dhan28) - T. Aus (BRRI dhan 42) - T. Aman (Binadhan-7) was tested against the existing one Boro (BRRI dhan28)-Fallow-T. Aman (BR 10). Higher gross return (Tk. 244505 ha^{-1}) and gross margin (Tk. 81195 ha^{-1}) were obtained from alternate cropping pattern.

Development of alternate cropping pattern Potato + Maize (as intercrop)-Jute-T. Aman against the existing cropping pattern Potato+Cucumber-T. Aman

An experiment was conducted at the MLT site Modhupur, Tangail during 2012-13 and 2013-14 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. Alternate cropping pattern Potato + Maize - Jute- T. Aman was tested against the existing patternPotato + Cucumber - T. Aman using RCB design with six dispersed replications. The alternate cropping pattern gave higher gross margin (Tk.386218 ha^{-1}) compared to existing pattern (Tk. 264034 ha^{-1}).

Improvement of existing cropping pattern Potato + Bitter gourd - T. Aman with Potato + bitter gourd + Pointed gourd (as intercrop) -Onion (bulb)

An experiment was conducted at the MLT site Modhupur, Tangail during 2013-14 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. Alternatecropping pattern Potato + Bitter gourd + Pointed gourd - Onion was tested against the existing patternPotato + Bitter gourd - T. Aman rice. The improved cropping pattern gave the higher gross margin (Tk.998943 ha $^{-1}$) compared to existing pattern (Tk.506878 ha^{-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 conducted at MLTsite Madhabpur, Habigonj during 2013-14 to study the performance of improved cropping pattern to increase the productivity and income of farmers. The cropping patterns were farmers existing patter Fallow-T. Aus-T. Aman (F) and alternate cropping pattern Wheat-Jute-T. Aman rice (FA) were evaluated using RCBD with six dispersed replications. BARI Gom 26 of wheat, CVL-1 of Jute and Binadhan-7 of T. Aman rice were used in this trial. Results revealed that the FA provided 9.92 t ha^{-1} rice equivalent yield that was almost 37.78% higher than that of F where the yield was gained 7.20 t ha^{-1}. Gross return and net return of FA were Tk. 248000 and Tk.138520 ha^{-1}, respectively whereas in F, these were Tk.180000 and Tk. 96750 ha^{-1}, respectively. However, the net profit in FA was 43.17 % more than that of F.

Improvement of Fallow-T. Aus-T. Aman cropping pattern with Mungbean-T. Aus-T. Aman in medium high land under rainfed condition

An experiment was executed during three consecutive years of 2012-14 at FSRD site, Jalalpur and MLT sites, Zakigonj, and Moulvibazar to evaluate the performance of improved cropping pattern to increase the productivity and income of farmers. The existing cropping patterns Fallow-T. Aus-T. Aman (F) and improve cropping pattern Mungbean-T. Aus-T. Aman rice (FA) were tested using RCB with six dispersed replications. BARI Mung-6 of mungbean, BRRI dhan48 of T. Aus and Binadhan-7 of T. Aman rice were used in this trial. The mean yield of Mungbean, T. Aus and T. Aman rice in improved cropping pattern were 1.11, 3.58 and 3.88 t ha^{-1}, respectively while in farmers existing cropping pattern the grain yield of T. Aus and T. Aman rice were 3.23 and 3.55 t ha^{-1}, respectively. Moreover, FA provided higher net return of Tk. 236570 ha^{-1} compared to F (Tk. 151160) ha^{-1}. Higher MBCR (2.48) was also recorded in FA.

Development of alternate cropping pattern Wheat-Fallow-T. Aman against farmers existing pattern Fallow-Fallow-T. Aman in coastal area

An experiment was conducted at MLT site, Kuakata, Patuakhali during 2014-15to develop a new cropping pattern introducing wheat to increase economic return. Alternate cropping pattern Wheat-Fallow-T. Aman was tested against farmers' existing pattern Fallow-Fallow-T. Aman using RCB design with six diperse replications. In Wheat-Fallow-T. Aman pattern, gross margin (Tk.54400 ha^{-1}) was higher than existing fermers' pattern (Tk. 4000 ha^{-1}). T. Aman rice var. BRRI dhan53 gave 48% higher yield than local variety.

Development of alternate cropping pattern Chilli-Fallow-T. Aman against farmers existing pattern Fallow-Fallow-T. Aman

The experiment was conducted at FSRD site, Razakhali, and MLT site Kuakata, Patuakhali during 2014-15 to determine the profitability of the alternate cropping pattern Chilli (BARI Morich-1)-Fallow-T. Aman rice (BRRI dhan 53) against the farmers' existing pattern Fallow-Fallow-T. Aman rice (local: Moulata) under AEZ 13 using RCB design with six disperse replications. The result revealed that the alternate cropping pattern was agronomically and economically profitable than the existing pattern. The highest gross return (Tk.434500 ha^{-1}) and gross margin (Tk.51300 ha^{-1}) were obtained from alternate cropping pattern over existing pattern.

Cropping pattern studies for increasing cropping intensity and productivity in rice based cropping system in Dinajpur

A study was carried out at Agricultural Research Station, Rajbari, Dinajpur with three rice based cropping patterns (with 4 crops), during 2012-13 to 2013-14 to see the agronomic and economic feasibility of the patterns and to increase the cropping intensity and productivity. The alternate cropping patterns were T. Aman rice–Mustard–Boro rice–T. Aus rice (FA_1), T. Aman rice–Potato–Boro rice–T. Aus rice (FA_2) and T. Aman rice–Mustard–Mungbean–T. Aus rice (FA_3). The predominant cropping pattern T. Aman rice–Fallow–Boro rice –Fallow (F) was used as check. Grain yield of rice, mustard and tuber yield of potato was satisfactory.The highest rice equivalent yield was obtained from the cropping pattern T. Aman rice–Potato–Boro rice–T. Aus rice (FA_1). Total variable cost, gross return and gross margin were higher in a cropping pattern where potato was included (FA_2).

Development of alternate cropping pattern against existing cropping pattern (Onion/Maize T. Aman rice) in high Ganges river floodplain

The experiment was conducted at MLT site, Puthia, Rajshahi during the 2012-13 and 2013-14 to study productivity, production efficiency, land use efficiency and economic return of some cropping patterns in High Ganges River Floodplain soils. There were three cropping patterns i.e., two alternate cropping patters over existing onion/Maize T. Aman ricewere studied. The alternate cropping patterns wereFA_1: mustard-onion/Maize T. Aman rice and FA_2: Potato-onion/Maize T. Aman rice. The experiment was conducted in RCB design with six dispersed replications. Improved cropping pattern viz. potato-onion/Maize T. Aman rice produced 39.38% higher rice equivalent yield (REY) followed by mustard-onion/Maize T. Aman (14.09%) compared to the existing onion/Maize T. Aman rice cropping pattern.

Development of alternate cropping pattern garden Pea-Boro-T. Aman against Fallow-Boro- T. Aman rice cropping pattern

The trail was conducted at MLT site Bheramara, Kushtia during 2014-15 in farmers' field condition to study the feasibility of growing garden pea as vegetable crop (cash crop) in the T. Aman –Garden pea – Boro rice cropping pattern. BARI Motorshooti-3 was well fitted as vegetable (pod) in the cropping pattern T. Aman – Fallow – Boro rice. Plot size was 0.13 ha in one replication. Gross margin of alternate and existing cropping pattern was Tk.232995 and Tk. 103131ha^{-1}, respectively.

Performance of garden pea relayed with T. Aman rice in fallow- Boro- T. Aman rice cropping pattern

The experiment was conducted at Muktagacha and Trishal MLT site area during 2014-15 to develop an economically profitable cropping pattern and to increase intensification of cropping by using fallow land before boro cultivation. The existing and alternate cropping patterns are T. Aman-Fallow- Boro and T. Aman/ Garden pea- Boro rice. Yield of T. Aman and Garden pea were recorded as 3.87 t ha^{-1}& 3.61 t ha^{-1}, respectively at Muktagacha and 3.85 t ha^{-1} & 3.9 t ha^{-1} respectively at Trishal in the alternate cropping pattern. Rice equivalent yield (17.36 and 18.07 t ha^{-1}) was found in improved cropping pattern. Gross margin (Tk. 123270 and 134210 ha^{-1}) was also higher in the improved cropping pattern at both locations.

Intercropping of radish/carrot/garlic/onion with Chilli

The experiment was executed at Bhabkhali, Mymensingh during rabi 2014-15 to find out the appropriate intercrop with chilli for higher productivity and maximum economic return. The experiment was consisted with five crop combination viz., sole chilli, chilli + radish, chilli+ carrot, chilli + onion and chilli + garlic. One row of each component crop was seeded in between two rows of chilli. The experiment was laid out in RCB Design with six dispersed replications. 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 Piaj 1) were planted in the field on 13 November, 2014. Seeds of radish (var. BARI Mula 4), carrot (var. New Kuroda) and cloves of garlic (var. BARI Rashun-1) were sown on the same day. Carrot was harvested at 55 and 90 days after sowing (DAS) while onion and garlic was harvested at 119 DAS, respectively. First harvest of green chilli was done at 109 DAP and continued up to 138 DAP. Significantly the highest yield (green chilli) was obtained with sole chilli (10.26 t ha^{-1}). Among the intercropping treatments, the highest chilli yield (10.31 t ha^{-1}) was obtained from chilli + garlic which was close to chilli + onion whereas the lowest (7.71 t ha^{-1}) was found in chilli + radish combination. Intercropping reduced 3 to 48 % chilli yield but total productivityincreased by 80-135% over sole chilli due to the contribution of companion crops.The highest chilli equivalent yield (25.01 t ha^{-1}), gross return (Tk.1365500 ha^{-1}) and gross margin

(Tk.1248500 ha^{-1}) were obtained from chilli + garlic combination. The results reaveled that chilli + garlic might be suitable combination for higher productivity and economic return.

Intercropping of red amaranth, coriander and radish with bottle gourd

A field experiment on intercropping of red amaranth, coriander and radish with bottle gourd was conducted at farmer's field of Muktagacha MLT site, Mymensingh during rabi 2014- 15 to evaluate the performance of bottle gourd production and to increase land use efficiency. Four crop combinations viz., 100% Bottle gourd + Red amaranth, 100% Bottle gourd + Coriander (leaf), 100% Bottle gourd+ Radish (leaf) and Sole bottle gourd were used. Results revealed that yield of bottle gourd was reduced by 6 to 20% due to the cultivation of companion crops but total productivity increased due to the contribution of companion crop. The highest bottle gourd yield (47.42 t ha^{-1}) was obtained from sole cropping and the lowest bottle gourd yield (39.73 t ha^{-1}) was found in 100% Bottle gourd + Radish (leaf) crop combination. The highest bottle gourd equivalent yield (54.45 t ha^{-1}) was recorded in 100% Bottle gourd + Coriander (leaf) crop combination. It also gave the highest gross margin (Tk. 3,59,380 ha^{-1}).

Intercropping of coriander with carrot

A field experiment on intercropping of coriander with carrot was conducted at farmer's field of Muktagacha MLT site, Mymensingh during rabi 2014- 15 to evaluate the performance of carrot production in intercropping system and to increase land use efficiency. Three treatments viz., Carrot (100%) + Coriander (1 time cultivation), Carrot (100%) + Coriander (2 times cultivation) and Sole carrot (100%) were considered. It was laid out in RCB design with six replications. The unit plot size was 3 m × 1 m. Seeds of carrot (var. New Quroda) and coriander (var. BARI Dhania 1) were sown on 13 November 2014 in 5 rows. The row was 20 cm apart from each other. Coriander was sown in between two rows. Second time sowing of coriander was done on 29 December' 2014. First time sowing coriander was harvested at 35-38 DASand Second time sowing coriander was harvested 36-39 DAS. Carrot was harvested on 24 February, 2015 (103 DAS). Intercropping reduced carrot yield but total productivity increased due to additional yield of coriander. Sole carrot produced the highest yield (34.22t ha^{-1}). Among the intercropping treatments, the highest carrot root yields (31.92 t ha^{-1}) were obtained from carrot (100%) +Coriander (1 time cultivation). The highest carrot equivalent yield (37.00 t ha^{-1}) was recorded in carrot (100%) + coriander (2 times cultivation). Carrot (100%) + coriander (2 times cultivation) gave the highest gross margin (Tk.595700 ha^{-1}).

Intercropping of onion and coriander with cabbage

An experiment on intercropping of onion and coriander with cabbage was conducted at the farmer's field of MLT site Trishal, Mymensingh during rabi 2013-14 and 2014-15 to study the feasibility of intercropping of onion and coriander with cabbage and to increase land use efficiency. Three intercropping combinations as T_1: sole cabbage (100 %), T_2: cabbage (100 %) + onion (25%), T_3: cabbage (100 %) + coriander (25%) were investigated. The experiment was laid out in RCB design with six compact replications. The unit plot size was 3m × 4m and plant spacing for cabbage was 60cm × 50cm, for onion 20cm × 15cm and for coriander 20cm × continuous in line. The tested varieties of cabbage, onion and coriander respectively were Atlas-70, BARI Piaj 1 and BARI Dhania 1. In T_1 treatment, thirty days old cabbage seedlings were planted on 5 November, 2014. In T_2 treatment, one row onion was in between two cabbage lines. In T_3 treatment, one row coriander was in between two cabbage lines. Head yield of cabbage was adversely affected by intercropping but total productivity increased due to additional yield of onion and coriander. The highest cabbage equivalent yield (81.33 t ha^{-1}) was obtained from T_3 treatment when coriander was intercropped with cabbage and the lowest cabbage equivalent yield (75.48 t ha^{-1}) was recorded in sole cabbage cultivation. Gross return (Tk. 851650 ha^{-1}) and gross margin (Tk. 613350 ha^{-1}) were highest in cabbage (100%) + coriander intercropping system.

Intercropping of red amaranth and coriander with cabbage

The experiment was conducted at the farmer's field of MLT site Trishal, Mymensingh during rabi 2014-15 to study the feasibility of intercropping of red amaranth and coriander with cabbage and to increase land use efficiency. Three intercropping combinations as T_1: sole cabbage (100%), T_2: cabbage (100%) + red amaranth (30%), T_3: cabbage (100%) + coriander (25%). The experiment was laid out in RCB design with six compact replications. The unit plot size was 3.6m x 5m and plant spacing for cabbage was 60 cm x 50 cm, for red amaranth 20 cm x15 cm and for coriander 20cm x continuous in line. The tested varieties of cabbage, red amaranth and coriander respectively were Atlas-70, BARI lalshak-1 and BARI Dhania-1. In T_1 treatment, thirty days old cabbage seedlings were planted on 12 November, 2014. In T_2 treatment, one row red amaranth was in between two cabbage lines. In T_3 treatment, one row coriander was in between two cabbage lines. Red amaranth seeds were planted on 15 November, 2014 and leaf was harvested on 17 December, 2014.Coriander seeds were sown on the same day (15 November, 2014) and leaves were harvested on 25 December, 2014. 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 (83.56 tha^{-1}) was obtained from T_3 treatment when coriander was intercropped with cabbage and the lowest cabbage equivalent yield (79.23 tha^{-1}) was recorded in sole cabbage cultivation. Gross return (Tk. 835600 ha^{-1}) and gross margin (Tk. 603300 ha^{-1}) were also highest in cabbage (100 %) + coriander (25%) intercropping system.

Intercropping of vegetables with hybrid maize

The experiment was conducted at MLT site, Phulpur, Mymensingh during rabi 2014-15 to study the feasibility of intercropping of vegetables with hybrid maize and economic returns. Four crop combinations viz.T_1: Sole maize, T_2: maize+red amaranth (leaf), T_3: maize+radish (leaf), T_4: maize + Spinach (leaf) were in the intercropping system. The crop combinations were arranged in RCB Design with four replications. The unit plot size was 8m × 5m. There were four crop combinations viz.$T_{1:}$ Sole Maize (var. BARI Hybrid Maize 9), T_2: Maize + Red amaranth (var. BARI Lalshak 1), T_3: Maize + Radish (var. BARI Mula 4) and T_4: Maize + Spinach (BARI Puishak 1) were used. Seed of red amaranth, radish, spinach were broadcast between two (75cm apart) rows of maize. The spacing of sole maize was 75 cm× 25 cm. BARI hybrid Maize 9 was sown on 20 December 2014. Vegetable seeds were sown on 2 January 2015. The highest maize equivalent yield (14.20 t ha^{-1}), gross return (Tk. 213000 ha^{-1}) and gross margin (Tk. 176520 ha^{-1}) were obtained from maize + red amaranth combination. The lowest maize equivalent yield (8.58 t ha^{-1}), gross return (Tk.128700 ha^{-1}) and gross margin (Tk. 92825 ha^{-1}) were obtained from sole maize cropping. Results revealed that maize + red amaranth could be profitable crop combination.

Intercropping garlic with chilli in the Haor area of Kishoreganj

The study was conducted at MLT site, Nikli, Kishoreganj during rabi 2014-15 to observe the performance of garlic as intercrop with chilli. Four treatments like sole chilli, chilli + one row garlic, chilli + double row garlic and broadcasting chilli + garlic were used in this study. The experiment was replicated among the four farmers followed by RCB design. The Balujhuri, a local chilli variety was used as test cultivar. The unit plot size was 6 m x 3 m. The chilli seedlings were sown with 30 cm × 25 cm spacing and garlic was with 10 cm× 10 cm on 24 October 2014. The garlic variety was BARI Roshun 3. The highest chilli equivalent yield (22.46 t ha^{-1}) was obtained from two row garlic with chilli intercropping and the lowest (15.57 t ha^{-1}) from sole chilli. The highest gross return (Tk.313600 ha^{-1}) and gross margin (Tk.182880 ha^{-1}) was also found in two row garlic with chilli and the lowest in broadcasting garlic with chilli..

Intercropping vegetables with maize in the Haor area of Kishoreganj

The study was conducted at MLT site, Nikli,Kishoreganj during rabi 2013-14 and 2014-15 to observe the performance of vegetables as intercrop with maize. Four treatments like maize + potato, maize + field pea, maize + red amaranth and sole maize were used in this study. The experiment was laid out in RCB design with six farmers' field. The used maize variety was BARI Hybrid Maize 9.The unit plot size was 6m × 5m. The seeds were sown with 75 cm × 20 cm spacing on 11 November 2014. The maize seeds were used at the rate of 30-35 kg ha^{-1}. At the same time of maize, potato, field pea and red amaranth were sown. Double row of field pea (L-L: 25 cm and P-P: 8-10 cm) and single row of potato (L-L: 75 cm and P-P: 20 cm) were sown in between the maize row. The red amaranth was sown with broadcasting method. The crops were harvested at their maturity. The highest maize equivalent yield (12.687 t ha^{-1}) in 2014-15 and 13.29 t ha^{-1} in 2013-14) was obtained from maize+potato intercropping and the lowest (7.48 t ha^{-1}) in sole maize. The highest gross return (Tk.202880 ha^{-1}) and gross margin (Tk. 115972 ha^{-1}) were also found in maize+ potato intercropping and the lowest in sole maize.

Intercropping of garden pea with maize in the coastal area of Khulna

The experiment was conducted at the MLT site, Dumuria, Khulna during rabi 2014-15 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 experiment was laid out in RCB design with three replications. The unit plot size was 3×2.5m. Seeds of maize and garden pea were sown on November 16, 2014. The highest maize grain yield (8.58 t ha^{-1}) was recorded from sole maize cropping ($T_{1,}$) and the highest maize equivalent yield (16.71 t ha^{-1}) was obtained from T_3 when BARI Motorshuti-3 was intercropped with maize.

Performance of intercropping of short duration leafy vegetables with elephant yam in the coastal area

The experiment was carried out at the MLT site, Satkhira during 2014-15 to observe the feasibility of intercropping of short duration leafy vegetables with elephant yam. Five intercropping combinations were investigated as T_1: Sole elephant yam, T_2: Elephant yam+Sabuj shak, T_3: Elephant yam+Red amaranth, T_4: Elephant yam+Indian spinach, T_5: Elephant yam+Kangkong with three replications. The variety of elephant yam, *sabujshak*, red amaranth and kangkong were local, local, BARI Lalshak-1 and BARI Gimakalmi-1, respectively. The unit plot size was 3m ×3m. Tubers of elephant yam were sown on May 19, 2014.Seeds of *sabujshak*, red amaranth Indian spinach and kangkong were sown on the same date. The highest yam yield (22.18 t ha^{-1}) was recorded from sole elephant yam cropping (T_1) and the highest elephant yam equivalent yield (30.40 t ha^{-1}) was obtained from T_4 where sabuj shak was intercropped with elephant yam. The highest gross return (Tk. 94850 ha^{-1}) and gross margin (Tk. 479700 ha^{-1}) was recorded from elephant yam + sabujshak combination.

Intercropping of cauliflower with brinjal

The experiment was carried out at Shibpur, Narsingdi during rabi 2014-15 to assess the performance of brinjal and cauliflower under sole and intercropping. Three treatmets viz. brinjal+cauliflower, sole brinjal and sole cauliflower were tested to assess the performance of vegetables. The experiment was laid out in RCB design with three replications. The unit plot size was 4m× 3m. Recommended fertilizer @ 175-30-75-5000 kg N- P- K ha^{-1} and cowdung was applied for brinjal and cauliflower.

Thirty days old seedlings of brinjal and cauliflower were transplanted in each plot on November 20, 2014 maintaining spacing 60cm x 45cm for cauliflower, 75cm x 60cm for brinjal and for intercropping treatment cauliflower seedlings were transplanted in between two rows of brinjal. In intercropping system the yield of both crops were reduced as compared to sole cropping. Brinjal equivalent yield (58.25 t ha^{-1}) in intercropping was higher than sole cropping of brinjal.(51.83 t ha^{-1}.). The highest gross margin (Tk.937650 ha^{-1}) was found in brinjal+cauliflower intercropping.

Performance of chilli and hybrid maize intercropping under different planting systems in Hilly areas

The experiment was conducted at farmers' field of Bandarban during rabi 2014-15 to find out suitable combination of hybrid maize and chilli intercropping system and to study the effect of intercropping on component crops and increase total productivity and economic return. Two intercropping combinations viz., Maize single row (100 cm x 25 cm) + 2 rows chilli (50cm x 40cm) and Maize single row (150 cm x 25cm) + 3 rows Chilli (50 cm x 40 cm) were evaluated against their sole crops. The experiment was laid out in a RCB design with three replications. The unit plot size was 4 m x 3 m. The hybrid maize (var. BARI hybrid maize 9) and chilli local were used in this intercropping experiment. Seeds of maize and chilli were sown on November 25-30, 2014 according to treatments. Green cob of maize was harvested at 135 and 142 DAS (5 and 12 April, 2015) and chilli was harvested at 112 DAT , 130 DAT and l52 DAT. Cob yield of hybrid maize and green fruit yield of Chilli was the highest in respective sole crops. The highest gross return (Tk. 162500 ha^{-1}) and gross margin (Tk 112500 ha^{-1}) were recorded in maize single row (150 cm x 25cm) + 3 rows Chilli (50cm x 40cm) combination. The results revealed that maize single row (150 cm x 25cm) + 3 rows Chilli (50cm x 40cm) combination might be suitable and economically profitable for the hilly areas.

Intercropping sweet potato with pulses, oil seed and spices crops at charland of Jamalpur

The experiment (viz. Sweet potato+ lentil, sweet potato+ linseed, sweet potato+ coriander and sweet potato sole) was conducted in the farmer's field at MLT site, Melandah during rabi 2014-15 to observe the productivity and economic feasibility of intercropping systems. The treatments were tested in RCB design with 6 dispersed replications. The unit plot size was 5m × 4m. The variety JSP-1, BARI Mosur 7, local and BARI Dhonia 1 were used for sweet potato, lentil, linseed and coriander, respectively. All intercrops seed were sown in broadcast maintaining the percentage of seeds of the respective crops. Sweet potato vines were sown in a planting configuration of 60cm × 30cm spacing. The crop was fertilized with 70-25-85 kg ha^{-1} NPK and 8 t ha^{-1} cowdung, respectively. Root yield of sweet potato was reduced due to intercropping systems. The highest root yield of sweet potato was found in sole sweet potato (38.28 t ha^{-1}) and the lowest (30.60 t ha^{-1}) when it was grown with coriander. The highest sweet potato equivalent yield was obtained from sweet potato+ lentil intercropping systems (42.44 t ha^{-1}) which gave 10.87% yield advantage over sole sweet potato. The gross return (Tk 424400 ha^{-1}) was found higher from sweet potato+lentil intercropping system.

Validation of spinach+sweet gourd intercropping system

An experiment was conducted in the farmer's field at FSRD site, Kushumhati, Sherpur during rabi 2014-15 to observe the productivity and economic feasibility of sweet gourd+spinach intercropping systems. The treatments were: 100% sweet gourd (2m × 2m) +100% spinach (broadcast), T_2= 100% sweet gourd (2m × 2m) +75% spinach (Broadcast) and T_3= Sole sweet gourd (2m × 2m). The treatments were tested in RCB design with 4 replications. The unit plot size was 4m × 4m. The variety BARI Mistikumra-2 and local were used for sweet gourd and spinach, respectively. Sweet gourd seedling was transplanted in 2m× 2m and spinach seeds were sown in broadcast maintaining the percentage of seeds. The seedling of sweet gourd and seeds of spinach were planted on 6 November,

2014. Three hand weeding was done at 20, 45 and 65 DAP. Fruit yield of sweet gourd was reduced due to intercropping systems. The highest fruit yield of sweet gourd was found from sole sweet gourd (45.45 t ha^{-1}) and lowest (41.43 t ha^{-1}) when it was grown with 75% spinach. The highest sweet gourd equivalent yield (62.42 t ha^{-1}) was obtained from 100% sweet gourd + 100% spinach, intercropping systems which gave 37.33% yield advantage over sole sweet gourd. The gross return (Tk. 312100 ha^{-1}) and gross margin (Tk. 206367 ha^{-1}) were found highest from 100% sweet gourd +100% spinach intercropping system.

Intercropping chickpea with foxtail millet in different plant population under rainfed condition in High Barind tract

The field trial was conducted at the farmer's field of Godagari, Rajshahi during rabi 2014-15 to find out the best compatible intercrop combination of chickpea with kaon in terms of economic return. The experiment was laid out in a RCB design with three compact replications. The unit plot size was 5 m x 6 m. There were five treatments combination viz., T_1= Sole chickpea (100%), T_2= Sole kaon (100%), T_3= chickpea (100%) + kaon (20%), T_4= chickpea (100%) + kaon (40), and T_5= chickpea (100%) + kaon (60%). The variety of chickpea and kaon were BARI Chola 9 and BARI Kaon-1, respectively. Seeds of both crops were sown on 13 November 2014 simultaneously. The crops were harvested on 16 March, 2015. Intercropping of chickpea and kaon controlled weeds, and intercropping ratio of chickpea (100%) + kaon (20%) gave the superior chickpea equivalent yield (1.50 t ha^{-1}) in compared to other intercropped treatment. The maximum gross return and gross margin were also recorded in the intercropping ratio of 100% chickpea + 20% kaon.

Performance of sowing time of maize as intercrop with potato at farmers field

The experiment was carried out at farmer’s field of MLT site Ranigonj, Dinajpur during rabi 2014-15 to evaluate the effect of potato intercropping on maize yield, appropriate time of intercropping maize with potato and the economic performance of the Maize potato intercropping systems. Three different intercropping combinations along with sole cropping of maize and potato were employed in the study following RCB design. The unit plot size was 10 m × 8 m. Spacing of maize was 75 cm × 25 cm under both sole and intercrop combination. Potato tuber was planted in single row between maize row maintaining 20 cm spacing from tuber to tuber under intercrop combination. In the case of sole potato, 60 cm × 25 cm spacing was maintained. Potato tuber (var. Diamant) under sole and intercropping were planted on November 10, 2014. Maize seeds (BARI Hybrid maize 9) Maize seeds under sole cropping were also planted on November 10, 2014. The results revealed that the highest yield of potato and maize was obtained from sole cropping of component crops. Under intercropping, the highest maize and potato yield was recorded in same day planting and sowing of potato and maize (T_1) and maize sowing at 35 DAP of potato, respectively. The highest maize equivalent yield, land equivalent ratio and percent land save were obtained in maize sowing at 20 DAP of potato (T_2). The highest gross return and gross margin were obtained in T_2, where maize sowing at 20 DAP of potato. The results indicated that maize sowing at 20 DAP of potato was found suitable for total productivity and economic return of the system.

Performance of mungbean as mixed crop with sesame

The field experiment was carried out at MLT site Atghoria, Pabna during kharif 2014 to verify the performance of mugbean as mixed crop with sesame. Six treatment combination viz. T_1= Mungbean (100%) + Sesame (20%), T_2= Mungbean (100%) + Sesame (30%), T_3= Mungbean (100%) + Sesame (40%), T_4= Mungbean (75%) + Sesame (20%), T_5= Mungbean (75%) + Sesame (30%) and T_6= Mungbean (75%) + Sesame (40%) along with sole sesame and sole mungbean were selected for the trial. The experiments were laid out in RCB design with six replications. Seeds of mugbean (BARI

Mug-6) and sesame (BARI Til-4) were sown on 26 March, 2014 as broadcast. The unit plot size was 16 m^2 (4 m x 4m). The highest yield was obtained from sole sesame due to higher plant population and number of seeds pod^{-1} compare to all the treatment combinations. Although all the treatment combination showed lower yield but provide higher mugbean equivalent yield compared to sole mugbean and sole sesame.Lower yield of mugbean and sesame may be due to prolonged drought condition during the cropping season. The highest gross margin of Tk. 23943 ha^{-1} was obtained from T_4 treatment.

Validation of mungbean and cowpea mixed cropping in Bhola

A field trial was carried out at MLT site, Sadar and Daulatkhan, Bhola under AEZ-18 during rabi 2014-15 to evaluate the comparative performance of mungbean and cowpea mixed cropping in different ratio. The treatments were sole mungbean, 90% mungbea+10% cowpea, 75% mungbean+25% cowpea and 50% mungbean+50% cowpea. The experiment was laid out in RCB design with six dispersed replications. The unit plot size was 8 m × 5 m. Crop was grown in rainfed condition. Mungbean and cowpea was harvested twice. Mixed cropping of 90% mungbean+10% cowpea gave the highest mungbean equivalent yield (1350 kg ha^{-1}) followed by sole mungbean (1337 kg ha^{-1}). Increasing cowpea seed rate decreased mungbean equivalent yield gradually. The highest gross return (Tk. 74265 ha^{-1}) and gross margin (Tk. 42185 ha^{-1}) was obtained from 90% mungbean + 10% cowpea mixed system.

Mixed cropping of mustard with lentil at different plant population at the charland of Bhuapur, Tangail

The experiment was conducted in the farmers' field at the MLT site, Bhuapur, Tangail during rabi 2014-15under AEZ 8 to verify the performance of lentil as mixed crop with mustard in char lands and to increase production and farmers' income. Four treatments viz. T_1: Sole lentil (100%), T_2: Lentil (100%) + mustard (10%), T_3: Lentil (100%) + mustard (15%) and T_4: Lentil (100%) + mustard (20%) were tested using RCB design with three dispersed replications. Seeds of lentil (BARI Mosur-6) and mustard (BARI Sarisha 11) were broadcasted on 03 to 07 December, 2014 as per the specification of the treatments. The unit plot size was 8 m x 5 m. Mustard was harvested on 15 to 18 March, 2015 whereas lentil on 21 to 26 March, 2015. The yield of lentil decreased with the increase of mustard population. All the mixed cropping combinations showed superior in terms of gross return, gross margin and lentil equivalent yield (LEY) than sole cropping. The highest lentil equivalent yield (1.35 t ha^{-1}) was found in 100% lentil + 20% mustard. The combination of 100% lentil + 20% mustard (T_4) gave the highest gross return (80724 Tk. ha^{-1}) and gross margin (Tk.49614 ha^{-1}) where sole lentil (T_1) gave the lowest gross return (74934 Tk. ha^{-1}) and gross margin (Tk. 44407 ha^{-1}) which indicated the advantage of mixed cropping over the sole cropping.

Performance of chickpea and mustard as a mixed crop in the coastal area of Patuakhali

An experiment was conducted at MLT site Amtali, Borguna and FSRD site Razakhali, Patuakhali during the Rabi season of 2014-15 to verify the performance of chickpea and mustard as a mixed crop in the coastal area under farmers' field condition. Six treatments with different ratios of mustard in chickpea (T_1: Chickpea 100%, T_2: 100% Mustard, T_3:100% chickpea + 15% Mustard, T_4: 100% chickpea + 20% Mustard, T_5: 100% chickpea + 25% Mustard, T_6: 100% chickpea + 30% Mustard) along with sole cropping were evaluated. The experiment was laid out in RCB design with six dispersed replications having unit plot size 8 m x 5 m. The seeds of chickpea (BARI Chola 8) and mustard (BARI Sarisha 14) was broadcast at a time on 11-12 December 2014. No diseases and pest infestation was found in chickpea but at later stage mustard was attacked by Aphid that was control by spraying Admire. Mustard was harvested on 23-25 February and Chickpea on 10-13 March 2015. At

Razakhali, maximum chickpea equivalent yield (1470 kg ha^{-1}) was recorded from treatment 100% chickpea + 15% Mustard (T_3) followed by 100% chickpea (T_2) (1375 kg ha^{-1}) and also the maximum gross margin (Tk. 29660 ha^{-1}) and the minimum gross margin (Tk. 14780 ha^{-1}) were obtained from T_3 and T_5 respectively. At Amtali, the maximum chickpea equivalent yield (1388 kg ha^{-1}) was attained from treatment 100% chickpea + 15% Mustard (T_3) followed by 100% Mustard (T_1) (1358 kg ha^{-1}). The maximum gross margin (Tk. 23920 ha^{-1}) and lowest gross margin (Tk. 11740 ha^{-1}) was obtained from T_3 and T_4 respectively. Therefore, 100% chickpea + 15% Mustard (T_3) could be suitable condition for higher production and economic return in the coastal areas of Patuakhali.

Performance of lentil as a mixed crop with mustard in the Noakhali region

The field experiment was carried out at MLT site, Feni during Rabi season of 2014-15. The treatment combinations used for the experiment were T_1 = Sole lentil (100 %), T_2 =Sole mustard (100%), T_3 = lentil (90%) + mustard (10 %), T_4 = lentil (80 %) + mustard (20 %), T_5 = lentil (70 %) + mustard (30 %), and T_6 = lentil (60 %) + mustard (40 %). Mustard variety (BARI Sarisha 14) and lentil variety (BARI Mashur 6) were used in this study. The experiment was laid out in RCB design with six dispersed replications. According to the treatments, seeds of Lentil (BARI Mashur-6) and Mustard (BARI Sarisha 14) were broadcasted on 29 November -10 December 2014. The unit plot size was 40 m^2 (10m x 4m). Mustard was harvested on 12-24 February 2015, whereas Lentil on 28 February-14 March, 2015. 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 (1444 kg ha^{-1}) was found in the treatment combination of lentil (80 %) + mustard (20 %). From the cost and return analysis it was observed that the combination of lentil (80 %) + mustard (20 %) (T_4) gave the highest gross return (115520 Tk. ha^{-1}) and gross margin (93890 Tk. ha^{-1}) where sole crop of mustard (T_2) gave the lowest gross return (64960 Tk. ha^{-1}) and gross margin (38690 Tk. ha^{-1}) which indicated the advantage of mixed cropping over the sole cropping.

Study on mixed lentil with mustard as relay crop with T. Aman rice

The trial was conducted at MLT site, Atghoria, Pabna during Rabi season of 2014-15. Primed seeds of lentil (BARI Masur 7) and mustard (BARI Sarisha 14) were sown as relay with T. Aman rice field. The seed rate of lentil and mustard were 50 and 0.7 kg ha^{-1}, respectively. The mean seed yield of lentil and mustard were 1778and 331 kg ha^{-1}, respectively. In case of mixed relay, lentil equivalent yield was 1973kg ha^{-1} which was 12% higher than farmers practiced sole relay lentil. Economic return in terms of gross margin was also higher in relay mixed cropping (Tk.123540 ha^{-1}) as compared with farmers' sole relay cropping (Tk.106333 ha^{-1}).

Performance of sweet gourd relaying with T. Aman in the Coastal area

The validation trial was conducted at MLT site Amtali, Borguna, FSRD site, Razakhai, and MLT site Kuakata, Patuakhali during the Rabi season of 2014-15 to verify the performance of sweet gourd relaying with T. Aman rice under farmers field condition. Two treatments: T_1: transplantation of polybag seedling in standing T. Aman rice field at 15 days prior to harvest and T_2: Farmer's practices (dibbling of sweet gourd seed after T. Aman rice field) were tested using RCB design with six dispersed replications.The plant spacing was 2m x 2m and var. Hybrid Bengal Sweet was used in this experiment. Sweet gourd seedlings were transplanted into standing rice field on 12 November to 08 December 2014 in treatment T_1. In farmers practice (T_2) seeds were sown directly from 25-30 December, 2014. In T_1 treatments, crops harvesting started from 05 March, 2015 and in T_2 harvesting started from 25 March, 2015. The highest fruit weight was also observed in T_1 treatment. Fruit yield was also significantly higher (27.65-34.25 t ha^{-1}) in treatment T_1 over T_2 (23.25-26.30 t ha^{-1}). As the plants in relay system got prolong residual moisture, which probably enhance higher yield.

Relay sweet gourd with brinjal at charland of Jamalpur

The experiment was conducted at MLT site, Melandah, Jamalpur during rabi season 2014-15. There were nine treatments viz. T_1= Brinjal (100%)/sweet gourd (local) 2m×1.5m, T_2= Brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×1.5m, T_3= Brinjal (100%)/sweet gourd (local) 2m×2m, T_4= Brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×2m, T_5= Brinjal (100%)/sweet gourd (local) 2m×2.5m, T_6= Brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×2.5m, T_7= Brinjal (100%)/sweet gourd (local) 2m×3m, T_8= Brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×3m, T_9= Sole brinjal (Local) 100cm×75cm) The result indicated that fruit yield of brinjal was reduced due to relay cropping systems. The highest fruit yield of brinjal was found from sole brinjal (55.71 t ha-1) and lowest fruit yield (42.60 t ha-1) was found when it was grown with brinjal 100%/ sweet gourd (Local) 2m × 1.5m. The highest brinjal equivalent yield was obtained from brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×2.5m relay cropping systems (64.12 t ha^{-1}) which gave 15.74% yield advantage over sole brinjal. The gross return (Tk.769440 ha^{-1}) was also found highest from brinjal (100%)/sweet gourd (BARI Mistikumra-2) 2m×2.5m relay cropping system.

Performance of sweet gourd relay with potato at varying plant population in High Barind tract

The study was carried out at farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during 2014-15 to find out the optimum plant population of sweet gourd in potato field and increase the farmers' income in High Barind Tract. In the the study, there were six treatments viz. T_1 = Sole potato, T_2 =Potato (100%) + sweet gourd (40%)(5m x 2m), T_3 = Potato (100%) + sweet gourd (60%)(3m x 2m), T_4 = Potato (100%) + sweet gourd (80%)(2.5m x 2m), T_5 = Potato (100%) + sweet gourd (100%)(2m x 2m) and T_6 = Sweet gourd @ 2500 seedlings ha^{-1}(2m x 2m) which was tested using RCB Design with six dispersed replications.).The variety of sweet gourd and potato was BARI Mistikumra 2 and Diamant, respectively. The potato seeds were sown on 24-26 Nov. 2014 with the line sowing (40 cm x 20 cm). Sweet gourd transplanted as relay with potato at 10-15 January 2015. The whole tubers were sown in this practice. The highest tuber yield was found in T_1 treatment followed by T_2, T_3 and T_4 whereas the highest sweet gourd yield was observed in sole sweet gourd treatment (T_6). Consequently, the highest potato equivalent yield was noticed in T_3 treatment (38.45 t ha^{-1}) followed by T_2 (38.23 t ha^{-1}) and T_5 (37.86 t ha^{-1}). The T_2 treatment gave higher economic return in terms of gross margin followed by T_3 and T_5.

Establishment of relay lentil with T. Aman rice as influenced by stubble height in High Barind Tract

An experiment was carried out at farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during rabi season of 2014-15 to find out the optimum height of rice stubble and the suitable time and soil moisture 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. Result showed that 20 cm stubble height and sowing of lentil at 20 days before harvest of T. Aman rice conserve more residual soil moisture than other stubble height and sowing time. The maximum seed yield was recorded from the treatment combination of 20 cm stubble height and 15 days before harvest of T. Aman rice (1.26 t ha^{-1}). Results reveal that sowing at 15 days before harvest of T. aman rice accompanied by 20 cm stubble height would be economically profitable method for lentil cultivation under rainfed condition in High Barind Tract.

Establishment of relay lentil with T. aman rice as influenced by stubble height

Relaying of lentil with T. Aman rice was evaluated at MLT site, Atghoria,Pabna during rabi 2014-15 to find out the optimum height of rice stubble, suitable sowing time and soil moisture for successful relay lentil production. The experiment was consisted of three rice stubble height viz. H_1= 10cm, H_2= 20cm, H_3= 30cm and four seed sowing time viz. S_1= 5 days before T. Aman harvest (DBTH), S_2= 10 DBTH, S_3= 15 DBTH, S_4= 20 DBTH. T. Aman rice stubble height had a subsequent effect on soil moisture content at early stage. Soil moisture content was higher in the plot containing long rice stubble (30cm), which also influenced lentil plant height at early stage. But during the later period it was non-significant and found that the increasing rate was lower in 30cm stubble height than others. Finally the plant height was higher in 20cm stubble height treatment. Seed relaying time also influenced plant height, where at early stage, the plant height was higher in seed sowing at 20 DBTH but at later period it was higher in 10 and 15 DBTH treatments. Soil moisture at early stage also had a little effect on plant establishment, where plant population was counted slightly higher in 30cm stubble height treatment. Higher main branch number per plant and pod per plant contributed more to produce higher seed yield in 20cm stubble height with 10 DBTH treatment.

Performance of grass pea as relay crop with T. Aman rice in low-lying areas of Narail

The field experiment was conducted at MLT site tularampur, Narail during rabi season 2014-15 to test the performance of BARI khesari 2 as relay cropping with T. Aman rice. The experiment icludes four treatments T_1= BARI khesari 2 relay with T. Aman rice, T_2= local (khesari) relay with T. Aman rice, T_3= BARI khesari 2 after T. Aman rice harvest and T_4= Khesari (local) after T. Aman rice harvest. The experiment was laid out in RCB design with six replications. Grass pea seeds were soaked in water over night before sowing. Sowing date of T_1 and T_2 were 05-09 November 15 days before rice harvesting and 24-26 November 2014 for T_3 and T_4. The crop was harvested on 13-23 March in 2015 when80%of the plant and pod turned to straw color. The highest yield (1.81 t ha^{-1}) of grass pea was obtained from T_1 treatment followed by T_2 (1.53 tha^{-1}). The lowest yield (0.43 t ha^{-1}) was observed in T_3 treatment. The maximum gross return of Tk. 54300ha^{-1} was obtained from the treatment T_1 due to higher yield followed by the treatments $T_{2.}$ The lowest gross return was observed in T_3 treatment (Tk. 12900ha^{-1}).

Effect of mulches on soil moisture conservation and yield of tomato

The experiment was conducted at Gadumiar Bazar, Bhaluka, Mymensingh during Rabi season of 2014-15 to find out the effect of mulching on tomato (BARI Hybrid Tomato 5) production. BARI Hybrid Tomato 5 was used in the experiment .Unit plot size was 4m × 1m with a spacing of 60 cm × 40 cm. Thirty days old seedlings were transplanted on 11 November 2014. Mulching with straw was done at vegetative stage. Tomato harvesting was started on 2 February 2015 and it was continued up to 03 March 2015. The highest fruit yield (70.48 t ha^{-1}) was obtained from BARI Hybrid Tomato 5 with straw mulch and without straw mulch produced the lowest yield (63.52 t ha^{-1}). Gross return (Tk. 1057200 ha^{-1}) and gross margin (Tk.804600 ha^{-1}) were also highest with straw mulch.

Effect of different amount of water hyacinth as mulch on potato and tomato in saline soil of Noakhali

The experiment was conducted at the farmer's field of FSRD site, Hazirhat, Noakhali during the Rabi season of 2014-15. Potato variety (BARI Alu 7) and tomato variety (BARI Tomato 14) were used in this study. Four 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 experiment same dried water hycinth mulch was used. The experiment was laid out in RCB design with six dispersed replications having unit plot size of 40 m^2 (10m × 4m). Potato variety (BARI Alu 7) and tomato variety (BARI Tomato 14) were used in this study. Incase of potato, tubers were planted @ 1.5 t ha^{-1} maintaining spacing 60 cm × 25 cm on 2 to 3 December, 2014. After that, plots were covered by water hyacinth according to the treatments. The crop was harvested on 8 to 10 March, 2015. Incase of tomato, 25 to 27 days old seedlings were transplanted on 2 to 3 December, 2014 maintaining spacing 60 cm × 40 cm. After fertilization, mulch was applied in experimental plots according to the treatments.The maximum soil moisture (%) status and the lowest salinity level (dS m^{-1}) recorded both for potato and tomato at harvest stage when mulched with 68 ton water hyacinth ha^{-1}. The highest tuber yield 26.46 t ha^{-1} and fruit yield 67.29 t ha^{-1} as well asgross margin Tk. 165800 and 646930 ha^{-1} obtained from T_4 treatment both for potato and tomato, respectively.

Effect of different levels of rice straw mulch on garlic under zero tillage cultivation

The experiment was conducted at MLT site Atghoria, Pabna during the rabi season of 2014-15 to ascertain the effect of different levels of rice straw mulches (T_1= rice straw @ 2 t ha^{-1}, T_2= rice straw @ 3 t ha^{-1}, T_3= rice straw @ 4 t $ha^{-1}$and T_4= Farmers practice@ 1.5 t ha^{-1}) on garlic. Immediately after receding of water from the field during the winter, the bulbs of BARI Rasun-1 was planted on November 12-15, 2014 in the muddy soil of the experimental plot maintaining spacing of 10 cm x 05 cm. According to treatment, dried rice straw mulch was uniformly placed in each plot immediately after planting of bulbs. The application of 2 and 3 t ha^{-1} rice straw mulch treatments showed significantly higher bulb diameter and bulb yield of garlic as compared to other treatments. Maximum gross return and gross margin was also achieved from 2 and 3 t ha^{-1} rice straw mulch application.

Influence 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 rabi season 2014-15 to find out suitable tillage practice and mulching for conserving residual soil moisture for tomato cultivation in High Barind Tract. There were two tillage methods viz., T_1= Minimum tillage (one ploughing) and T_2= Conventional tillage (four ploughing) in combination with three mulching practice viz. M_1= No mulch, M_2= Rice straw mulch @ 3 t ha^{-1} and M_3= Rice straw mulch @ 5 t ha^{-1}. 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 (54.59 t ha^{-1}) and gave higher economic benefit than that with other treatments. The results indicate 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.

Evaluation of mulches for enhancing lac production in ber under rainfed condition in Bangladesh

The study was undertaken at Farming System Research and Development (FSRD) site, Kadamshahor, Godagari, Rajshahi during 2013-2014 and 2014-15 at baishakhi lac crop season to observe the yield potentiality of lac and to evaluate the performance of different mulches on soil moisture retention, soil temperature and weed suppression in High Barind Tract. The lac insect settlement on the host, the nymphal secretion covered its body forming cell in which the life cycle was completed from November to June for brood lac and November to May for stick lac. The highest mortality was noticed in control (89.13% and 88.89% in 2013-14 and 2014-15 respectively) and the lowest yield was 2.53 kg $tree^{-1}$ 2.51 kg $tree^{-1}$in 2013-14 and 2014-15 respectively. On the contrary, the lowest mortality was found in black polyethylene mulch (83.71% and 82.76 in 2013-14 and 2014-15 respectively) and highest yield was 6.90 kg $tree^{-1}$ and 7.05 kg $tree^{-1}$ in 2013-14 and 2014-15 respectively followed by white transparent polyethylene (5.80 kg $tree^{-1}$ and 5.97 kg $tree^{-1}$) and straw mulches (4.90 kg $tree^{-1}$ 5.08 kg $tree^{-1}$) in 2013-14 and 2014-15 respectively. Black polyethylene mulch conserved the highest soil moisture and was found significant over control in all others treatments. Soil temperature recorded was found to be the highest under white transparent polyethylene mulch while the lowest temperature was recorded from control. Observations on weed biomass indicated that black polyethylene was superior over other mulch materials.

Effect of sowing dates on yield of soybean in High Barind Tract

The field trial was conducted at the farmer's field at FSRD site Kadamshahar, Godagari, Rajshahi during rabi season of 2014-15 to find out the suitable sowing date for soybean cultivation in rabi season under rainfed condition in High Barind Tract. BARI Soybean-5 was planted on three sowing dates: T_1 (1 Dec), T_2 (6 Dec) and T_3 (11 Dec). The experiment was laid out in a RCB design with three dispersed replications. The treatment T_1 (1 Dec) produced the highest seed yield (1.88 t ha^{-1}) and T_3 (11 Dec) gave the lowest one (1.07 t ha^{-1}). Result indicated that soybean should be sown by 1 December in High Barind Tract.

Influence of sowing date on the yield of coriander at charland of Mymensingh

The experiment was conducted at char land of Kalirbazar in Mymensingh during Rabi season of 2014-15 to find out the optimum sowing date for maximizing the seed yield of coriander. There were four planting time viz. 30 October, 15 November, 30 November and 15 December. The seeds were sown as per date mentioned in the treatments with a spacing of 30 cm × 15 cm. The crop was harvested on 25 February, 7March, 16 March and 27 March 2015. The highest seed yield (1.63 t ha^{-1}) was obtained from 30 October sowing time which was identical to 15 November (1.50 t ha^{-1}). The lowest seed yield was recorded from 15 December sowing time (1.10 t ha^{-1}). The highest gross return (Tk. 197660 ha^{-1}) and gross margin (Tk. 140960 ha^{-1}) were also found from 30 October sowing time.

Effect of planting technique on tuber yield of potato at Charland eco-system

The experiment was conducted at MLT site of Bheramara under Kushtia district during rabi season, 2014-15 to find out the tuber state (cut or non cut) along with spacing for higher yield of potato at charland eco-system and to compare farmers practice with recommended one. The variety was BARI Alu 8 (Cardinal). Treatments ware T_1: Recommended system of planting (60cm × 30cm), T_2: Single eye planting (30cm × 10cm), T_3: Single eye double row zig zag system (10cm/30cm × 10cm) and T_4: Half cut tuber (45cm × 15cm) was followed in the experiment. The potato tuber was planted during 29 November to 1st December, 2014. The highest tuber yield (28.77 t ha^{-1}) and gross return (Tk. 345240 ha^{-1}) as well as gross margin (Tk. 212565 ha^{-1}) were obtained from treatment T_4 (Half cut tuber along with 30 cm x 15 cm spacing) among other treatments.

Effect of planting time on the production of mungbean

The experiment was carried out at MLT site of Kushtia sadar under Kushtia during the kharif I season of 2013-14 to find out the optimum planting time of mungbean cultivation in changing climatic condition and to increase yield and farmers income. Three treatments T_1= 10 March, T_2= 20 March, T_3= 30 March were evaluated. The variety was BARI Mung 6. Seeds were sown on 10-30 March, 2014 at Kushtia with a spacing of 30cm x 5cm. Unit plot size was 10m x 10m. The crop was harvested during 12 May to 6 June 2014. The highest seed yield (1593 kg ha^{-1}) was obtained from T_1 (10 March) and the lowest yield (1153 kg ha^{-1}) in T_2 (20th March). The yield of T_2 treatment was affected by rainfall at 2nd harvesting time. Three times picking was done in T_1 treatment and two times picking was done in other two treatments. The maximum gross return (Tk.71685 ha^{-1}) and gross margin (Tk. 29160 ha^{-1}) were also obtained T_1 By 10 March.

Influence on planting dates on yield and quality of true seeds of onion

A field experiment was undertaken to find out the optimum planting time for maximizing true seeds of onion. The experiment was laid out at MLT site, Joybpurhat during October 2014 to April 2015. The treatments were three planting dates viz. 30 October, 10 November and 20 November. Row to row and bulb to bulb were 25 cm and 20 cm, respectively. Each plot had four rows. Fifteen seed bulbs were sown in each row. BARI Piaj-1 was used as test crop. Harvesting was continued for 3-7 days. Among different planting dates, 10^{th} November was the best for true seed production of onion at Joypurhat region.

Effect of different tillage system for wheat cultivation

An experiment was conducted in the farmers' field of two MLT sites, Bhuapur and Ghatail, Tangail under AEZ-8 during the rabi season of 2014-15 to select the suitable tillage system/cultural practice for wheat cultivation and to increase yield and economic return of the farmers. Two treatments viz. T_1:seed sown by PTOS (Power tiller operated seeder) and T_2: Conventional tillage/Farmers' practice were tested using RCB design with six replications. BARI *Gom* 26 was used as variety in both treatments and at the both locations. The seeds were sown during 01 to 04 December, 2014 at Bhuapur and 26 to 30 November, 2014 at Ghatail. In T_1 treatment seeds were sown in lines maintaining 20 cm line to line spacing. The crop was harvested during 17 to 20 March, 2015 at Bhuapur and 15 to 19 March, 2015 at Ghatail. The highest grain yield of wheat (3.74 and 3.58 t ha^{-1}) was obtained from T_1 (Seed sown by PTOS) and lower grain yield (3.42 at Bhuapur and 3.31 t ha^{-1}atGhatail) from T_2 (Conventional tillage/Farmers' practice). Higher gross margin (Tk. 42805 ha^{-1}at Bhuapur and Tk. 33905 ha^{-1}at Ghatail) was also obtained from T_1 and lower gross margin (Tk. 31555 ha^{-1}at Bhuapur and Tk. 23755ha^{-1}at Ghatiail) was obtained from T_2 due to reducing time and cost of production.

Effect of different tillage method for mungbean cultivation

An experiment was conducted at FSRD site Razakhali, Patuakhali in late rabi season of 2015 to verify the effect of different tillage method for Mungbean cultivation in coastal area of Patuakhali under farmers' field condition. Three different methods viz.T_1= Seeds own with PTOS, T_2= Seed sown by strip tillage, T_3= Conventional tillage/farmers practice were tested using RCB design with six dispersed replication. Seeds of BARI Mung 6 was sown on 02 February 2015. In case of Kuakata, sowing was done on 14 January 2015. PTOS and Strip tillage required fertilizer was applied in the field prior to tilling by seeder attached power tiller. But in conventional tillage fertilizers were applied at final land preparation. In case of strip tillage pendamethiline herbicide was applied before 7 days to sowingHarvesting was tarted from 23 April and continued to May 15. The maximum seed yield (1.53 tha^{-1}) was recorded from T_1 treatment at Razakhali followed by T_3 treatment (1.27 t ha^{-1}).

Effect of different sources of irrigation water on the yield of some vegetable crops

The experiment was conducted at the MLT site, Dumuria, Khulna in *Rabi* season 2014-15 under four water sources *viz*. pond water, river water, shallow tube well water and deep tube well water with four winter vegetables *viz*. tomato (BARI Tomato 14), cabbage (Atlas-70), cauliflower (White content) and knolkhol (Challenger) to find out the suitable sources of water for the production of tomato, cabbage, cauliflower and knolkhol. The unit plot size was 4x8m with three replications. Seedlings of 30 day old were transplanted in the main field on November 19, 2014 to December 02, 2014. Plant spacing maintained for the vegetable crops were as follows-tomato: 60 x 40 cm, cabbage: 60 x 45 cm, cauliflower: 60 x 45 cm and knolkhol: 60 x 45cm. The crops were harvested at different times as tomato: January 20 to February 20, 2015; cabbage: December 30, 2014 to January 15, 2015; cauliflower: December 30, 2014 to January 15, 2015 and knolkhol: December 30, 2014 to January 10, 2015. Significant variation was observed regarding yield and yield contributing characters among the vegetable crops grown with irrigation water of different sources. Salinity of irrigation water was found the lowest in case of pond and resultantly each crop irrigated with this water gave the highest yield compared to those of other irrigation sources.

Influence of priming on the yield of maize, wheat and lentil at farmers field

The study was carried out in order to evaluate effect of seed priming on seed germination and yield of maize, wheat and lentil at MLT site Jhikargacha, Jessore and Tularampur, Narail during 2014-15. The experiment was laid out in a RCB design with four replications. The experiment includes three priming methods viz. T_1= hydro-priming, T_2= osmo-priming (3% $ZnSO_4$) and T_3= non priming (dry seed). Maize seeds were taken in plastic bowls and submerged with distilled water / osmotic solution of 3% $ZnSO_4$ for 18 hours. After 18 hours of treatment the seeds were taken out from the bowl and washed under tap water for several times. Then it was surface dried for two hours under shade condition. In the same way wheat and lentil seeds were primed for 12 and 8 hours respectively. Maize seeds were sown on 28 November 2014 maintaining the spacing of 60 cm x 20 cm. The crop was harvested on 07 April 2015. Wheat Seeds were sown on 22 and 26 November 2014 at Jhikargacha and Tularampur resp. maintaining the spacing of 20 cm x 5 cm. Individual plot size was 3m x 2m. The crop was harvested on 18 to 20 March 2015. Lentil Seeds were sown on 20 November, 2014 and 24 November 2014 in Jhikorgacha, Jessore and Tularampur, Narail resp. maintaining the spacing of 30 cm x 10 cm. Individual plot size was 3m x 2m. The crop was harvested on 10 March 2015 in Jhikorgacha, Jessore and 15 March in Tularampur, Narail. Results showed that hydroprimed maize seeds increased germination percentage of all crops. Maize grain yield was highest (10.74 t ha^{-1}) from hydroprimed seeds followed by non primed seeds and it was lowest (9.63 t ha^{-1}) from osmoprimed seeds. The highest grain yield of wheat (4.31 t ha^{-1}) and (4.39 t ha^{-1}) were observed from hydroprimed seeds at MLT site Jhikargacha and Tularampur resp. whereas these were lowest from osmoprimed seeds at both locations. Grain yield of lentil was found highest (1.49 t ha^{-1}) and (1.46 t ha^{-1}) from hydroprimed seeds at MLT site Jhikargacha and Tularampur resp. followed by non-primed seeds and these were lowest from osmoprimed seeds at both locations.

Evaluation of linseed lines/variety against varying degrees of soil salinity

The experiment was conducted in the farmer’s field at FSRD site, Hazirhat, Noakhali during Rabi season 2014-15 under rainfed condition to evaluate the linseed lines/variety at varying degrees of soil salinity. Three linseed lines i.e. JL-2, JL-3, MCGR and BARI developed high yielding variety BARI Tishi-1 were tested in this trial. The experiment was laid out in RCB design with three dispersed replications. Unit plot size was 8m x 5m. Seeds were sown @ 8 kg ha^{-1} in line with 30 cm spacing on 7 to 9 December, 2014. Soil moisture regimes of the experimental plots were recorded at a depth of 0-15 cm at 15 days interval by using gravimetric method. Harvesting of the crop was done on 17 to 20 March, 2015. The highest seed yield (1106 kg ha^{-1}) was obtained from BARI Tishi-1 followed by MCGR (1045 kg ha^{-1}) whereas the lowest seed yield was recorded from the JL-3 (795 kg ha^{-1}). Salinity level gradually increased up to maturity stage of the crop. Emergence stage is more susceptible to soil salinity compared to other stages. JL-2 gave satisfactory yield upto10.22 dS m^{-1} salinity at maturity stage where 67% plants were survived and JL-3 can be grown within the salinity level 2.78 to 9.71 dS m^{-1} from emergence to maturity stage. MCGR gave satisfactory yield upto12.40 dS m^{-1} salinity at maturity stage when 65% plants were survived. BARI Tishi-1 tolerate to salinity level 3.25 to 12.83 dS $m^{-1}$from emergence to maturity stage maintaining plant population at satisfied level.

Performance of different hybrid maize varieties in Rabi season

The experiment was conducted at MLT site Manikganj during the rabi season of 2014-15 to evaluate the performance of hybrid maize varieties under farmer’s field condition with a view 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. The crop was sown on 30 Oct. - 2 Nov. 2014 and harvested on 1-

7 April, 2015. The experiment was laid out in RCB design with six dispersed replications having plot size of 10 m × 10 m with an inter plot distance of 0.50m. The highest grain yield (10.03 t ha^{-1}) was obtained from Elite followed by BARI Hybrid Maize 9 (9.87 t ha^{-1}), Miracle (9.85 t ha^{-1}), Pacific 984 (9.41 t ha^{-1}) and the lowest grain yield (9.01 t ha^{-1}) was recorded in the variety NK-40. Maximum gross return (Tk. 168710 ha^{-1}) and gross margin (Tk. 90530 ha^{-1}) was obtained from Elite due to higher yield followed by BARI Hybrid Maize 9 (Tk. 166100 and Tk. 87920 ha^{-1}, respectively) and the minimum from NK-40 (Tk. 151850 and Tk. 73670 ha^{-1}, respectively).

Performance of wheat varieties under late sowing condition

A field trial was carried out at Katlamari village of Bhaluka in Mymensingh district during Rabi 2014-15 to evaluate the performance of wheat varieties under late sowing (9 December) condition. Three wheat varieties viz. BARI Gom 25, BARI Gom 26 and BARI Gom 27 were evaluated. The yield performance of BARI Gom 27 and BARI Gom 25 appeared to be promising in late sowing condition. The design of the experiment was RCB design with six dispersed replications. The unit plot size was 5 m × 4 m. The seeds were sown continuously in 20 cm row to row distance on 9 December, 2014. The crop was harvested on 25 March, 2015. The highest grain yield (3.76 t ha^{-1}) was obtained from BARI Gom 27 followed by BARI Gom 25 (3.54 t ha^{-1}) whereas the lowest yield was obtained from the variety BARI Gom 26 (2.82 t ha^{-1}).

Performance of minor spices in coastal area

The experiment was conducted in the farmer’s field at FSRD site, Hazirhat, Noakhali during Rabi season of 2014-15 to see adoption and yield potential of minor spices in coastal area and popularize the spices varieties in the coastal region. Four minor spices viz., Fenugreek (BARI Methi 1 & BARI Methi-2), Black cumin (BARI Kalozira-1), Dill and Ajhowan were tested in this trial. 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 1391kg ha^{-1}. The average yield of BARI Kalozira-1, Dill and Ajhowan were 812.7 kg ha^{-1}, 1420 kg ha^{-1}and 524 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}, 0.72-4.81dS m-^{1}, 0.75-5.61 dS m^{-1}and 0.62-4.95 dS m^{-1} for fenugreek, black cumin, dill and ajhowan, respectively from emergence to maturity stage.

Maize cultivation through conservation tillage practices in Haor area of Kishoreganj

A field study was conducted at Shingpur haor, Nikli, Kishoreganj during the Rabi season of 2014-15 to observe the performance of minimum tillage on maize and introduce minimum tillage in haor areas. The experiment was laid out in a RCB design with three replications. There were four treatments viz. Zero tillage, Minimum tillage (2-3 cm furrow), Conventional tillage (8-10 cm depth), conventional tillage with earthing up. The variety was BARI Hybrid Maize 9. Among the treatments, zero tillage was maintained by bamboo stick. The maximum soil moisture was recorded from the zero tillage treatment. The highest yield (9.01 t ha^{-1}) was found from conventional tillage which was more or less similar to others tillage system. The highest gross return (Tk.156800 ha^{-1}) and gross margin (Tk. 99860 ha^{-1}) was obtained from conventional tillage with earthing up.

Screening of different crops and crop varieties for charland of Bhuapur

A trial was conducted in farmers’ field at the MLT site, Bhuapur, Tangail during the rabi, 2014-15 under AEZ-8 to select BARI released suitable crops or crop varieties for char land areas of Bhuapur, Tangail.Eight rabi crops (wheat, maize, mustard, soybean, potato, onion, garlic and chilli) with twenty-one varieties were tested in RCB Design with 6 dispersed replications. Among the crops, garlic, onion, potato, maize and wheat gave higher gross returns (Tk. 401500, Tk. 228000, Tk. 210300, Tk. 156600

& Tk. 107000 ha^{-1}) and gross margins (Tk. 284327, Tk.151455, Tk.113842, Tk.70500 & Tk.53504 ha^{-1}) in charland of Bhuapur, Tangail.

Moisture monitoring schedules in chickpea and lentil field with different tillage options under rainfed conditions in High Barind Tract

Crop production is highly constrained by moisture stress during winter season in the High Barind Tract of Rajshahi, Bangladesh. The experiment on chickpea and lentil was conducted at the farmer's field of FSRD site Kadamshahar, Gudagari during 2013-14 & 2014-15 to find out the means of combating the stress through agronomic manipulation like tillage method for better soil moisture and crop performance. The experiment was conducted in RCBD with six dispersed replications. Six tillage methods viz., (i) T_1= One conventional tillage, (ii) T_2= Two conventional tillage, (iii) T_3= Three conventional tillage, (iv) T_4= One power tiller operated tillage, (v) T_5=Two power tiller operated tillage and (vi) T_6= PTOS just after harvest of T. aman rice were studied under rainfed condition. Effect of tillage practices was found significant on soil moisture conservation and crop performance. Sowing of chickpea and lentil just after harvest of T. aman rice with PTOS was found to conserve more soil moisture than other tillage methods. Tillage practice significantly influenced the yield and yield components of lentil. During 2014-15, PTOS tillage gave consistently the higher seed yield for chickpea (1.66 t ha^{-1}) and lentil (1.37 t ha^{-1}) than conventional tillage. Two power tiller operated tillage gave the second highest grain yield for both chickpea (1.58 t ha^{-1}) and lentil (1.24 t ha^{-1}. Similar trends was found in 2013-2014. The result revealed that tillage of chickpea and lentil field just after harvest T. aman rice with PTOS might be a good option for better soil moisture conservation and for higher yield and economic return in the High Barind Tract of Bangladesh.

Performance of turmeric varieties in mango-turmeric agroforestry system

The trial was conducted at the farmers' field of Bandarban hill district during Kharif-I, 2014 to evaluate the performance of BARI released turmeric varieties in mango-turmeric agroforestry system. The highest turmeric yield was obtained from BARI Halud-4 (20.83 t ha^{-1}) and differed from other two BARI Halud varieties. The plot size was 8m × 5m. The spacing maintained was 50 cm × 25 cm. The experiment was laid out in RCB design with six dispersed replications. These two varieties were BARI Halud-3 and BARI Halud-5 which gave yields of 17.62 t ha^{-1}and 12.76 t ha^{-1}, respectively. The local variety produced the lowest yield of 11.27 t ha^{-1}. Farmers preferred BARI Halud-4 for its disease resistance, attractive color and higher yield than the local variety.

Performance of different creeper vegetables on non-fruit trees at homestead area in High Barind Tract

Non fruit trees are the important plant in High Barind Tract (HBT) due to their drought tolerant capacity. The study was conducted at Kadamshohor, Rajshahi to find out the combinations of creeper vegetables and non-fruit trees in homestead area for vegetables production. Three non-fruit trees involving Palmyra palm, Babla and Neem trees were used for cultivating six different creeper vegetables namely bottle gourd, white gourd, country bean, sponge gourd, ribbed gourd and potato yam. One tree was considered as a treatment. The experiment was laid out in a factorial RCB Design with three replications. Neem tree produced the highest bottle gourd equivalent yield (BEY) (15.10 kg tree^{-1}). Among the creeper vegetables, Bottle gourd gave the highest BEY (12.97 kg tree^{-1}) and lowest in sponge gourd (4.38 kg tree^{-1}). So, farmers in HBT can chose Neem tree for Bottle gourd production.

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 FSRD site, Pushpopara, Pabna during 2014-15 to see 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. *Dioscorea bulbifera* and *D. alata*. The selected supporting trees were 2 to 4 years old for Mahogani and Drumstick where the age range was 1 to 3 years for Jiga. Seed tuber of *D.bulbifera* and *D. alata* were planted on 2-5 May, 2014 and 14 May, 2014, respectively maintaining one seed per pit. The pit size was 50cm × 50cm × 50cm. The crops were harvested during 05 December to 25 January, 2015. The tuber yield of both yam species were significantly affected by both tree species and planting distance, where D. bulbifera performed better on Mahogani tree with 75 cm planting distance and D. alata performed better on Drumstick tree with 75 cm planting distance. Number of tuber plant and single tuber weight were also followed the above trend in both yam species. Tuber to tuber distance was increased where the number of tubers was decreased followed by yield decreased. The tuber initiation was started earlier but total tuber setting duration was taken longer period by *D. alata* than *D. bulbifera*. Closure planting distance (50cm) of yam from supporting tree shortened the tuber initiation duration, lessened tuber weight and final yield in both yam species.

Performance of turmeric under the niche of mango orchard

The experiment was carried out at FSRD site, Pushpopara, Pabna (N=24˚01′938″, E=089˚20′117″), during 2014-15 under AEZ-11. Four turmeric varieties viz. BARI Halud 3, BARI Halud 4, BARI Halud 5 and Local were used in the study. The experiment was laid out in RCB design with three replications under mango orchard. The unit plot size was 5 m x 4 m. The seeds of turmeric were sown on 6 May, 2014 maintaining 50 x 25 cm^2 spacing. Turmeric was harvested on January 12, 2015. From the results it was found that BARI Halud 4 and BARI Halud 5 produced statistically higher rhizome yield 26.90 t ha^{-1} and 21.56 t ha^{-1}followed by BARI Halud-3 (17.33 t ha^{-1}). The rhizome weight $plant^{-1}$ was statistically highest in BARI Halud 4 variety but the numbers of tiller $plant^{-1}$was statistically highest in local variety.

Evaluation of some management packages against pod borer infesting chickpea in the farmers' field of Barind area

The study was conducted at Godagari, Rajshahi during the rabi season of 2014-15 to find out an environment friendly management approach of chickpea pod borer at Barind area. There were four treatments viz. T_1= Pheromone trap + Sequential release of bio-control agents (Trichogramma chilonis & Bracon hebetor) + Spraying of HNPV @ 0.1g $litre^{-1}$ of water, T_2= Pheromone trap + Sequential release of bio-control agents (Trichogramma chilonis & Bracon hebetor) + Spraying of spinosad 45 SC (Tracer) @ 0.4ml $litre^{-1}$ of water, T_3= Farmers' practice: Spraying of Chlorantraniliprole + Thiamethoxam (Voliam flexi 300 SC) @ 0.5 ml $litre^{-1}$ of water and T_4= Untreated control (Water spray only). The experiment was laid out in a RCB design factorial with four dispersed replications. IPM package (T_1) showed the best performance reducing 70.16% pod damage over control and provided significantly the highest yield (1.54 t ha^{-1}) which was 61.05% yield increased over control. From the combined effect of different management packages and chickpea varieties was observed that BARI Chola 9 gave the highest yield (1.62 t ha^{-1}) followed by BARI Chola 5 (1.45 t ha^{-1}) both from the treatment T_1. Consequently, the highest benefit cost ratio (2.32) was also recorded from the package T_1 treatment of BARI Chola 9. Hence, bio-control agents release along with installation of sex pheromone traps and spraying of HNPV may be recommended for effective management of pod borer attacking chickpea.

Evaluation of different management packages against flower thrips and pod borers of mungbean in High Barind Tract

The experiment was conducted at Godagari, Rajshahi during Kharif-1 2015 with a view to developing environment friendly effective and economic management approaches against flower thrips and pod borers of mungbean and producing toxic synthetic insecticide free mungbean. Some management approaches were taken against flower thrips and pod borer complex of mungbean. There were four treatment viz. T_1= IPM Package 1: Planting site sanitation + installing white sticky trap + two sprays of Azadirachtin 1EC (Bio-neem plus) @ 1 ml L^{-1} water first at flower imitation stage and second at after 7 days interval (peak flowering and podding stage) + third spraying with Spinosad (Success 2.5 SC) @ 1.25 ml L^{-1} of water at seed developing stage (7 days after second spray), T_2= IPM Package 2: Planting site sanitation + installing white sticky trap + two sprays of Chlorfenapyr (Intrepid 10 SC) @ 1 ml L^{-1} water first at flowering imitation stage and second at after 7 days interval (peak flowering and podding stage) + third spraying with Emamectin Benzoate (Proclaim 5 SG) @ 1 g L^{-1} of water at seed developing stage (7 days after second spray) T_3= Farmer practice : Three spraying of Imidachloprid (Admire 200SL) @ 0.5 ml L^{-1} of water at 7 days interval starting from flower initiation stage and T_4= Untreated control (Water spray only). The experiment was laid out in RCB design with four replications. The highest seed yield was obtained in T_2 (1.44 t ha^{-1}) and followed by T_1 (1.33 t ha-1) and the lowest was untreated control. The highest gross margin (Tk. 66175 ha^{-1}) was obtained from T_2 followed by T_1 (59963 Tk. ha^{-1}). The highest marginal benefit cost ratio (MBCR) (2.06) was obtained from T_2 and the lowest was T_1 (1.34).

Seasonal incidence and management of common cutworm on aroid at farmers' field condition

An experiment was conducted at the MLT site, Joypurhat during 2014-15 to observe the performance of integrated management practice against common cut worm in aroid under farmers' field condition. The experiment was laid out with 6 dispersed replications. The variety was BARI Panikachu-2. There were two treatments viz. T_1: IPM Approach (Pheromone trap + Collection and destruction of egg masses & larvae+ application of SNPV @ 0.2 g/L of water) and T_2:Farmers practice (with insecticide-Morter 48 EC (Chlorpyriphos) @ 2ml/L of water, 10 times spray at 7 days interval). Traps were placed uniformly throughout each field with equal spacing of 20m × 20m between traps. The seedlings (Head) was sown 10-30 December, 2014. The trap was set on 18–22 February, 2015. For the fulfillment of scientific condition of the sex pheromone, farmers practice plot was placed 500 m away from the sex pheromone plot. The harvesting was started 30^{th} January 13 and continued upto 20^{th} May 2015. Crop under pheromone trap based IPM approach resulted comparative lower leaf & stolon damage and produced higher yield than farmers' practice (with insecticide). Maximum population of the pest was observed during August-September & March-April.

Development of management approach against tube spittle bug attacking ber

A study was conducted at the farmer's ber orchard of Sherpur, Bogra and Godagari, Rajshahi during rabi 2014-15 to develop a suitable management approach against Tube spittle bug attacking ber. There were five treatments viz. T_1 = Clean cultivation + Collection and destruction of tube (with alive nymph) from the branches, T_2 =T_1 + Two Sprays of Azadiractin 1 EC @ 1 ml/L of water (at initial stage of infestation and 10 days after 1^{st} spray), T_3 =T_1 + Sprays of Imidacloprid @ 0.2g/L of water at initial stage of infestation, T_4 =T_3 + One additional spray of Imidacloprid at 10 days after 1^{st} spray and T_5 = Untreated control. Single tree was considered as an experimental unit. The treatments were randomly allotted in each replication. Date of flowering was 5-20 September 2014 and date of tube initiation started from 20 September 2014. Sprays were done with a high volume foot pump sprayer. A main branch of the selected trees were examined thoroughly (at three days interval) to record no of tube/branch, no of alive nymph/branch and infested inflorescence/branch. Data were collected during flowering period of the crop. Fruits were harvested on 5 February-8 March 2015 in Bogra and 5-15 March in Barind. The lowest infestation and highest yield was also obtained from the treatment T_4 in both locations. Highest gross and net return was also obtained from the treatments. It was observed that the pest attacks the crop at the time of flowering and suck sap from the inflorescence so control measure should be taken at the beginning of infestation.

Management of banana leaf and fruit beetle with netting and polyethylene bagging at farmers' field

An experiment was conducted at Shibganj, Bogra and Godagari, Rajshahi during 2014-15 to reduce banana leaf and fruit beetle infestation at farmers' field condition. Three treatments viz: T_1: Banana bunch covered with netting (54 inch long and 36 inch wide), T_2: Banana bunch covered with polyethylene bagging (54 inch long and 36 inch wide) and T_3: Farmers' practice (with insecticide) was considered in this regard. The unit plot size was 8m x 4m. Eight plants were considered per treatment. The variety was Rangin Maher Sagar in Bogra and Sabri in Rajshahi. Suckers were planted on 30 October 2013 in Bogra and 5 April 2014 in Rajshahi. The banana bunches were covered with nets/polythene bags during 5 June-20 June 2014 in Bogra and 5 December-5 January 2015 in Rajshahi irrespective of farmers and as per growth and development of bunch. Recommended fertilizer doses were used to grow the crop. In polythene bag treatment, bags were checked to remove moisture from the bag. The crop was harvested treatment wise during 14 October to 12 November 2014 in Bogra and 7 March-18 April 2014 in Rajshahi.Lower infestation was observed in T_1 and T_2 against Farmers' practice (T_3) in both locations. Gross margin was obtained from T_2 which was closely followed byT_1 and the lowest in farmers' practice.

Integrated approaches for controlling purple blotch disease of onionin true seeds production

The experiment was conducted at Sadar, Faridpur during the period of November 2014 to April 2015 with the objectives to evaluate the effect of bio-fungicide in combination with chemical fungicide for controlling of purple blotch disease of onion as well as for higher yield and economic return. The unit plot size was 2 m x 2 m. Taherpuri variety of onion was used. The eight treatment combinations were as follows: T_1= Rovral and Ridomil 4 times spray, T_2 = Rovral + Secure + Antracol + Indofil M -45 one time spray each, T_3 = Rovral and Ridomil 2 times + Trichoderma harzianum one time + Sanitation, T_4 = Trichoderma harzianum two times + Rovral and Ridomil 1 time + Sanitation, T_5 = Trichoderma harzianum compost + T_3, T_6 = Trichoderma harzianum compost + Trichoderma harzianum 3 times + Sanitation, T_7 = Score 2 times + Rovral and Ridomil 2 times and T_8 = Control.Control of purple blotch of onion was achieved by spraying fungicide (chemical plus bio) with Trichoderma compost in treatment T_5 followed by T_3 andT_4 treatment. The highest seed yield (580 kg ha^{-1}) was obtained from treatment T_5 where T.compost + Rovral and Ridomil + T. harzianum + Sanitation were applied. The highest BCR (3.92) was observed from T_5.

Efficacy of fungicide against diseases of mustard in Haor area

The study was conducted at Goroy, Nikli, Kishoreganj during Rabi season of 2014-15 evaluate the performance of fungicide to control diseases of mustard and to popularize disease free mustard seed production. The trial consisted of four treatments viz; T_1: Seed treatment with provex (3g/kg seed), T_2: Seed treatment with provex + foliar application with rovral, T_3: Foliar application with rovral and T_4: Farmers practice (Without fungicide). The unit plot size was 10cm × 10m. The seeds were sown on 3-5 November, 2014 followed by broadcasting method. Pest management was done carefully with the participation of farmers. Though the farmer's dose was very high but they used this dose to get residual effect in boro season. The crop was harvested on 1st week of February 2015. The design was randomize complete block with three replications. The highest diseases infestation was found in T_1

and T_2 treatments. The highest yield (1.49 t ha^{-1}) was observed from T_2 treatment and the lowest (1.19 t ha^{-1}) from T_4 treatment. It also provided maximum gross return (Tk.52150 ha^{-1}) and gross margin (Tk.28870 $ha^{-1.}$).

On-Farm trials with advanced lines and technologies

Adaptive trial of BARI released wheat varieties

A field trial was carried out at Joypurhat, Kushtia, Bhola, Faridpur, Kishoreganj, Manikganj, Munshiganj and Dinajpur during 2014-15 to evaluate the performance of BARI developed wheat varieties at farmers' field condition. Wheat varieties viz. BARI Gom 24, BARI Gom 25, BARI Gom 26, BARI Gom 27and BARI Gom 28 were evaluated. The experiment was laid out in RCB design with six dispersed replications. The unit plot size was 5 m × 4 m. The variety BARI Gom 26 produced higher yield in all the locations whereas BARI Gom 28 performed better in Joypurhat, Manikganj and Munshiganj. Farmers' of Joypurhat, Kushtia, Manikganj and Munshiganj preferred BARI Gom 28 whereas farmers of Faridpur, Bhola and Munshiganj preferred BARI Gom 26 due to higher yield and less pest and disease infestation.

Adaptive trial of advance wheat lines

An experiment was conducted at the farmers' field of MLT site, Ghatail, Tangail, Barura, Comilla and on station OFRD, Comilla during Rabi, 2014-15 in irrigated medium high land situation to evaluate the performance of advance lines of wheat developed by BARI. It was laid out in RCB design with three replications. Three advance lines viz. BAW-1135, BAW-1170 and BAW-1177 along with BARI Gom 24 as check were tested. The unit plot size was 5 m x 4 m. Among the tested lines, the highest grain yield (3.89 t ha^{-1}) was obtained from BAW-1170 in Tangail and BAW-1177 (4.77 to 5.48 t ha^{-1}) in Comilla for both on station and on farm trial. The lowest yield was obtained from the variety BARI Gom 24 in all locations. Farmers showed their interest to the new advance lines BAW-1170 & BAW-1177 due to their higher yield potentiality and less disease infestation and 6 to 9 days earlier than BARI Gom 24.

Adaptive trial of advance Durum lines

Performance of eight new durum lines as E_1, E_2, E_3, E_4, E_5, $E_{6,}$ E_7 andE_8 were evaluated at the farmers' field in Faridpur during rabi, 2014-15. The trial was laid out in RCB design with three replications. Unit plot size was 2.4 m x 5 m. Seeds were sown on 7 December 2014. Two irrigations were given at 21 and 60 DAS and one hand weeding was done at 37 DAS. The crop was harvested at 5-9 April 2015. Among the tested genotypes, the maximum days to maturity (120 days) were recorded in E_5 and the minimum (116 days) in E_2, E_4 and E_8. Genotype E_1 performed better and produced the highest grain yield (3.08 t ha^{-1}) due to maximum number of grain $spike^{-1}$ (39.65) and 1000 grain weight (38.9 g). Lowest yield (2.78 t ha^{-1}) was obtained from E_7. Farmers dislike this advance durum lines due to the longer field duration (116 to 120 days) and smaller grain size compared to other cultivated modern varieties of wheat and lower market price.

Adaptive trial of BARI hybrid maize varieties

The experiment was conducted at Bhola, Kishoreganj, Bandarban and Dinajpur during Rabi 2014-15 to observe the performance of BARI Hybrid Maize varieties and popularize them among the farmers. Three BARI developed maize hybrid viz. BARI Hybrid Maize 5, BARI Hybrid Maize 7 and BARI Hybrid Maize 9 and a check variety (NK-40) were tested. Unit plot size was 8m × 5m. Seeds were sown in lines maintaining line to line spacing 60 cm and plant to plant spacing 20 cm. BARI Hybrid Maize 9 produced the highest yield in Kishoreganj and Bhola whereas NK-40 in Bandarban and Dinajpur. Farmers preferred both the varieties NK-40 and BARI Hybrid Maize 9 due to higher grain yield and attractive color of the varieties. Scarcity of irrigation water was the main problem in Bhola. Seeds of BARI Hybrid Maize should be available in local markets.

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

A field experiment was conducted in the farmers' field of Godagari upazila under Rajshahi district in High Barind Tract during Rabi 2014-15 to test the performance of locally developed promising low water required hybrid maize and selection of medium height variety for Barind areas. Eight lines/varieties viz. P_1xP_4, P_1xP_7, P_2xP_5, P_2xP_6, Q_1xQ_2, P_1xP_2,Shuvra and Zimbabwetested in the farmer's field of High Barind Tract. The experiment was carried out in RCB design. Each entry was cultivated on irrigated and non-irrigated condition for each location. The seeds were sown in maintaining the spacing of 75 x 20 cm. Seeds were sown on 24-30 November 2014. The crop was harvested on 2-6 May 2015. The plant height and ear height were the highest in Suvra and Zimbabwe while Q_1xQ_2 and P_1xP_2 were the short variety. The Suvra matured earliest time but it gave lowest yield and had lodging tendency. There is no yield difference of white maize genotype between irrigated and non-irrigated conditions. The higher yields were obtained from the treatments P_2xP_5,P_1xP_2 and P_1xP_4, in both irrigation regimes.Farmers were enthusiastic about white maize as some white maize lines viz. P_2xP_5,,P_1xP_7 and P_1xP_4 provided higher yield undernon-irrigated condition.

Adaptive trial of barley varieties in Southern belt and Barind tract

The experiment was conducted at the farmer's field of Noakhali, Khulna and Rajshahi during the Rabi season of 2014-15 to observe the performance and popularize BARI Barley varieties in saline and drought prone area. Four varieties of barley viz, BARI Barley 3, BARI Barley 4, BARI Barley 5 and BARI Barley-6 were used in Khulna and Rajshahi whereas BARI Barley 3, BARI Barley 4 and BARI Barley-6 were tested in the saline area of Noakhali. The experiment was laid out in a RCB design with three dispersed replications having plot size 10mx10m with an inter plot distance of 0.50 m. Among the tested varieties the highest grain yield was observed in BARI Barley 6 (above 2.50 t ha^{-1}) in all the locations but yield (1.32 t ha^{-1}) was low in Noakhali due to high salinity during grain filling stage. In Rajshahi and Khulna, the seeds were sown in line with 25 cm spacing with seed rate 100 kg ha^{-1} whereas seeds were broadcasted in Noakhali with 120 kg ha^{-1}. Farmers were encouraged to observe the yield performance of BARI Barley 6 and BARI Barley 4 but threshing and processing is laborious and a problem opined.

Adaptive trial of millet varieties in char areas

Three millet varieties viz., BARI Kaon 1, BARI Kaon 2 and BARI Kaon 3 were evaluated at the farmer's field of MLT site, Melandah, Jamalpur during 2014-15. The unit plot size was 7m × 6m. Seeds were sown on 24 November, 2014 and harvested at 23 March, 2015. The highest grain yield (2.80 t ha^{-1}) was recorded from BARI Kaon 2 and BARI Kaon 1 produced the lowest grain yield (2.02 t ha^{-1}). Farmers were satisfied with BARI Kaon-2 for its higher yield but marketing facility was limited.

Adaptive trial of newly released potato varieties

The trial was conducted at farmers' field of Tangail, Rangpur, Khulna, Jamalpur, Gopalganj, Bhola, Barind, Kushtia, Comilla, Patuakhali and Faridpur during Rabi season of 2014-15 to evaluate the performance of tuber yield of selected potato varieties. Potato varieties viz. BARI Alu 13 (Granola), BARI Alu 24 (Dura), BARI Alu 25 (Asterix), BARI Alu 31 (Sagitta), BARI Alu 33 (Almera), BARI Alu 36 (4.26 R), BARI Alu 41 (5.183), BARI Alu 42 (Agila), BARI Alu 45 (Steffi), BARI Alu 7 (Diamant), BARI Alu 8 (Cardinal), BARI Alu 28(Lady Rosetta), BARI Alu 34 (Laura), BARI Alu 43 (Atlas), BARI Alu 44 (Elgar), BARI Alu 35 were tested in different locations. The trial was laid out in

RCB design with three dispersed replications. The unit plot size was 5m × 4m. Seed tubers were planted at a spacing of 60cm × 25cm.Among the tested potato varieties, BARI Alu 41, BARI Alu 42 (Agila) and BARI Alu 35 performed better in most of the locations. Scab infestation was observed at most of the locations and its severity was high with variety Diamant. Late blight disease was observed in some locations. Farmers' choice of potato variety varied with locations mostly for yield performance and skin colour. According to farmers' choice present popular variety Diamant could be replaced by BARI Alu 41, BARI Alu 42 (Agila) and BARI Alu 35. Farmers of Khulna, Jamalpur, Kushtia, Barind and Faridpur preferred BARI Alu 35, whereas farmers of some locations liked Diamant, BARI Alu 42 and BARI Alu 44.

On-Farm trial of newly released potato varieties in Sylhet region

A study was carried out at MLT sites, Zakiganj and Sunamgonj and FSRD site, Jalalpur during 2013-15 to select suitable variety of potato for Sylhet region. There were five varieties i.e., Diamant, Granula, Cardinal, Asterix and Lady Roseta used in the trial. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 4m x 5m. Potatoes were sown on 25-28 November maintaining the spacing of 60cm x 15cm. The potato was harvested on 5-8 March. The highest tuber yields 17.50 and 17.59 t ha^{-1} were recorded from Asterix at Jalalpur and Diamant at Zakiganj, respectively. AtSunamgonj Diamant produced the highest tuber yield (17.47 t ha^{-1}). Previous year's results remarked that higher yield of potato was also obtained in Diamant variety at Sunamgonj location in 2013-14. Farmers preferred both Asterix and Diamant Potato verities due to higher yield in Sylhet region.

Adaptive trial of newly released sweet potato variety

A field trial was carried out at Mymensingh, Patuakhali, Jamalpur, Jessore and Rangpur during Rabi, 2014-15 to evaluate the comparative performance of BARI released high yielding sweet potato varieties. Four varieties viz. BARI SP 10, BARI SP 11, BARI SP 12 (conducted at Jessore), BARI SP 13 along with local check were evaluated in the study. The unit plot size was 6m × 6m. Sweet potato vines were planted maintaining a spacing of 60 cm x 30 cm. The yield performance of all the varieties appeared to be promising in the tested locations. Among the varieties BARI SP 11 produced highest yield in all locations except Jessore where BARI SP 13 produced the highest yield. Farmers were interested to grow BARI Sweet Potato 11 due to its higher yield. The pulp color is white as that of local variety. The farmers showed interest to grow BARI Sweet Potato 11 if vines are available during growing season.

Adaptive trial of BARI released panikachu varieties

Three panikachu varieties viz., BARI Panikachu 2, BARI Panikachu 3 and a local variety were evaluated at the farmer's field of the MLT site, Melandah, Jamalpur during 2013-14. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 10m x 8m. The seedlings of panikachu were sown on 28-30 October 2013 with a spacing of 60 cm × 30 cm. Stolon harvest was started from 25 March and continued up to 28 June 2014. The rhizome was harvested on 15-31 July 2014. The highest rhizome yield (42.28 t ha^{-1}) was obtained from the local variety whereas the highest stolon (24.51 t ha^{-1}) yield was recorded from BARI Panikachu 2. Farmers were satisfied with BARI Panikachu 2 for its higher yield.

On-Farm trial of BARI developed bottle gourd variety for summer season

The trial was conducted at Patuakhali, Jamalpur, Comilla and Pabna during Kharif 2014 to evaluate BARI developed high yielding summer bottle gourd variety. BARI Lau 4 and local (check) were used in this trial. The trial was laid out in RCB design with six replications. The unit plot size was 10 m x

2.5 m. Seeds were sown with a spacing of 3 m x 2 m. BARI Lau 4 gave higher yield compare to their local variety in all the locations. Farmers opined that BARI Lau 4 is an excellent variety for summer season. They were pleased on the yield of BARI Lau 4 for its high yield potential in off season.

Adaptive trial of bottle gourd varieties with different spacing for leaf purpose

An experiment was conducted in the farmers' field at FSRD site, Elenga, Tangail during the Rabi season of 2014-15 to find out the suitable variety and spacing of bottle gourd for leaf purpose and to increase production and farmers' income. Three varieties of bottle gourd viz. BARI Lau 3, BARI Lau 4 and Local were tested with four plant spacing viz. 30cm × 20cm, 35cm × 10cm, 40cm × 10cm and 40cm × 20cm. The experiment was laid out in RCB design with three replications. The unit plot size was 4m×2m. The seeds were sown on 27 to 29 October 2014. Harvesting was started from 41 DAS and it was continued upto 101 DAS. Among the varieties the highest twig yield (37.09 t ha^{-1}) and gross margin (Tk. 411078 ha^{-1}) was obtained from BARI Lau 4 with 30cm × 20cm plant spacing. Farmers were interested to cultivate bottle gourd as twig and leaf purpose for higher yields and benefit.

Adaptive trial of BARI released sweet gourd varieties at charland

A field trial was carried out at Bhabkhali, Mymensingh sadar during Rabi, 2014-15 to evaluate the performance of BARI released high yielding sweet gourd varieties viz. BARI Mistikumra 1, BARI Mistikumra 2 with a localvariety. The design was RCB with six dispersed replications. The unit plot size was 6m x 16m. The seeds were directly sown on 31 October, 2014 maintaining a spacing of 2 m x 2 m. The maximum fruit yield was produced in BARI Mistikumr 2 (27.40 t ha^{-1}) which was statistically similar with BARI Mistikumra 1 (25.16 t ha^{-1}) and local variety produced the lowest yield (21.95 t ha^{-1}). Farmers were interested to cultivate BARI sweet gourd varieties due to their higher yield, compactness and family sized fruit as compared to local variety. Some farmer's stored seed from the experimental field for next year cultivation.

On-Farm trial of BARI developed ridge gourd variety

A field trial was conducted at Muktagacha, Mymensingh Sadar, Rangpur and Jessore during Kharif 2013-14 to evaluate the performance of BARI Jhinga 1 with a local cultivar. The experiment was laid out in RCB with six dispersed replications. BARI Jhinga 1 and local variety were tested. The plot size was 1.25 m × 7.5 m and spacing was 1.5 m x 1.5 m. The ridge gourd var. BARI Jhinga 1 produced the highest yield in all the locations compared to local variety. Farmers' of Muktagacha and Mymensingh Sadar were satisfied to get higher yield of BARI developed ridge gourd variety. They prefer it for its deep green color and early fruiting. But the farmers of Jessore were not interested to cultivate BARI Jhinga-1 as the fruit length of this variety is shorter than local variety and market price of this variety was also low.

On-Farm trial of BARI developed snake gourd variety

A field trial was conducted at Muktagacha under Mymensingh district during Kharif 2014 to evaluate the performance of BARI Chichinga-1 with a local cultivar. The experiment was laid out RCB with six dispersed replications. The unit plot size was 1.25 m × 7.5 m. Seeds were sown on 06 March, 2014 maintaining a spacing of 1.5 m x 1.5 m. Fruits were harvested on 07 May to 12 July, 2014. The highest marketable yield 22.35 t ha^{-1} was recorded from BARI Chichinga-1 than local cultivar (17.07 t ha^{-1}). Farmers' were satisfied to get higher yield of sanke gourd var. BARI Chichanga 1. They like it for its green color, narrow shape and 5-6 days earlier fruiting than local variety.

Adaptive trial of country bean varieties

A field trial was conducted at MLT site under Kishoreganj during Rabi, 2014-15 to observe the performance of BARI developed country bean varieties. Two BARI developed varieties viz, BARI

Shim 1, BARI Shim 6 along with local check were evaluated in the study. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 6 m x 2 m. The seeds were sown on 8-12 October, 2014. The crop was harvested from 5 January 25 to 18 February 2015. BARI Shim-1 produced the highest yield (19.16 t ha^{-1}) followed by BARI Shim 6 (14.06 t ha^{-1}but the lowest (11.82 t ha^{-1}) was in local.The country bean var. BARI Shim 1 gave higher yield but BARI Shim-6 was at least 15 days earlier than others two varieties. BARI Shim 6 may be popular to consumer's due color, size, softness and higher market price though lower yield of BARI Shim 1.

On-Farm trial of BARI developed country bean variety

The experiment was conducted at Jessore, Chittagong, Rangpur, Sylhet, Mymensingh and Bandarban during Rabi season 2014-15 to evaluate the performance of BARI developed country bean variety BARI Shim 6 along with local variety under farmer's field condition. The trial was laid out in a RCB design following six dispersed replications. The unit plot size was 6m x 3m. The pit was prepared by maintaining spacing of 1.5 m x 1.5 m. The country bean var. BARI Shim-6 performed better in respect of pod yield than local variety in different locations except Sylhet where local varieties performed better. Farmer's preferred BARI Shim-6 due its higher yield, size and test. The market demand was also higher. In Sylhet region farmers preferred local variety than BARI varieties.

Performance of BARI developed country bean varieties in Sylhet region

A field experiment was conducted in FSRD site, Jalalpur and MLT site, Zakiganj, Sylhet during Rabi season of 2014-15 to test the performance of BARI develop country bean varieties along with IPSA Shim 2 and local one. Five country bean varieties viz. BARI Shim 1, BARI Shim 4, BARI Shim 6, IPSA Shim 2 and Goalgada (Local) were evaluated. The trial was laid out in RCB design with four dispersed replication. The unit plot size was 5m x 4m. The pit was prepared by maintaining spacing (1.5m×2.5m). Fifteen days old seedlings of two country bean varieties were planted on 15-20 September. The green pod (bean) was harvested from 15 December to 10 March, 2015. Local cultivar Goalgada produced higher pod yield than other tested varieties in both locations.The pod yield of country bean was higher in Jalalpur than Zakiganj. Farmers opined that Goalgadda cultivar is tasty than those of improved varieties. The profuse fruiting and pod yield were the important consideration to farmers about local Goalgada. However, they also showed interest on BARI Shim-6 as its production is almost similar to that of Goalgada. The pest and disease infestation was also lower compared to local one.

Performance of bushbean varieties in Sylhet region

An experiment was conducted at FSRD site, Jalalpur, and MLT sites, Moulvibazar and Zakiganj during two consecutive years 2013-14 and 2014-15 to select a suitable variety of bushbean (French bean) and to increase crop production as well as income of the farmers. The experiment was laid out in a RCB with six dispersed replications. There were eight different varieties and lines i.e., BARI JharShim-1, BARI JharShim 2, BARI JharShim 3, Local-1(black), Local 2 (white colour with chocolate spot at hylum), Loca 3 (coffee colour), Local-4 (coffee colour with few chocolate spot) and Local-5 (black with chocolate colour spot). The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 4m x 5m. Seeds were sown on 15-20 November, in both the years maintaining the spacing of 25 cm x 10 cm. The crop was harvested on 25-28 February. Mean yield of two years in three locations of Sylhet revealed that all the varieties and lines showed better performance at Zakiganj than other two locations. Local cultivars produced significantly higher yield than BARI developed bushbean varieties.

Adaptive trial of BARI released garden pea varieties

The experiment was conducted at FSRD site, Hatgobindapur, Faridpur during Rabi, 2014-15 to evaluate the performance of newly released garden pea varieties. The tested varieties were BARI Motorshuti 1, BARI Motorshuti 3, Natore Local 1, Natore Local 2 and Faridpur Local. The unit plot size was 4 m x 3 m. Seeds were sown on 12 November 2014 with a spacing of 30 x15 cm. Green pod of different garden pea varieties was harvested through two times picking. The maximum green pod yield was obtained from BARI Motorshuti-1 (10.8 t ha^{-1}) and the lowest (4.1 t ha^{-1}) in local variety. Farmers preferred BARI Motorshuti-1 for its higher yield, less labor requirement for pod picking due to lower plant height. Some farmer's prefered Natore Local-1, Natore Local-2 and Faridpur Local due to high demand in local market. The local varieties had thin pod wall and light green pod than BARI released varieties.

On-Farm trial of BARI developed eggplant variety

The adaptive trial was conducted at Pabna, Comilla, Narasindi, Rangpur, Chittagong, Jamalpur and Tangail during *Rabi*, 2014-15 to evaluate the performance of BARI released eggplant variety (BARI Begun 10) with local one. The trial was laid out in RCB design with 6 dispersed replications. The unit plot size was 6 m x 1 m with a spacing 100 cm x70 cm. BARI Begun-10 performed better yield and economic return than local variety in all locations. Relatively higher yield of BARI Begun-10 encouraged farmers towards cultivation of this variety. Farmers also like the shape, size and color of the variety. Comparatively infestation percentage was less which attracted the farmers.

On-Farm trial of Bt Brinjal varieties

The trial was conducted at 108 farmers' field of 19 districts such as Dinajpur, Rangpur, Gaibandha, Bogra, Joypurhat, Rajshahi, Pabna, Kushtia, Meherpur, Jessore, Bhola, Jamalpur, Mymensingh, Tangail, Manikganj, Gazipur, Narsingdi, Comilla and Chittagong during *Rabi* 2014-15 to observe the performance of four Bt brinjal varieties viz. BARI Bt Begun-1, BARI Bt Begun-2, BARI Bt Begun-3 and BARI Bt Begun-4 at the farmers' field. Two rows of non Bt counterparts of the varieties were also planted as border crop. Unit plot size was 1330 m^2 with spacing of 100 cm×100 cm. Stable bleaching powder was applied 15-20 days before transplanting @ 21 kg per hectare for preventive measure against bacterial wilt. BARI Bt Brinjal varieties performed better over their non Bt counterparts in respect of BSFB infestation and yield in all locations of the country. BARI Bt Brinjal varieties showed 0-0.33 percent shoot and 0-5.12 percent fruit infestation against 21.54-65.0 percent shoot and 32.8-78.0 percent fruit infestation respectively in non-Bt counter parts. This technology is highly effective against the target insect pest, BSFB. But sporadic infestation of other non-target sucking pests, like white fly, jassid, aphid, mite etc. and diseases (bacterial wilt, fusarium wilt, phomopsis blight etc.) was observed in some locations. For large scale demonstration, more awareness should be developed for the cooperative farmers about the Bt technology and management of the non-target insect-mite pests & diseases.

On-Farm trial of BARI developed tomato varieties

The experiment was conducted at Comilla, Rangpur, Jessore, Patuakhali, Pabna, Chittagong, Bandarban and Sylhet during Rabi, 2014-15 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. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size 4m×1m. BARI Tomato 14 produced highest yield in all locations except Jessore and Pabna where local and BARI Tomato 15 produced higher yield. Farmers are interested to grow BARI developed tomato varieties i.e. BARI Tomato 15 and BARI Tomato 14 due to their higher yield.

On-Farm trial of BARI developed winter hybrid tomato varieties

The experiment was conducted at Comilla, Rangpur, Jessore, Pabna, Norsingdi, Bandarban, Chittagong, Mymensingh and Shyampur during Rabi, 2014-15 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 in the study. The experiment was laid out in a RCB design with six dispersed replications. The unit plot size was 4m×1m. BARI Hybrid Tomato 5 performed better in all locations except Chittagong and Mymensingh where BARI Tomato 7 produced higher yield. Farmers preferred tomato var. BARI Hybrid Tomato 5 and BARI Hybrid Tomato 7 due to their higher yield and attractive color. Disease infestation was relatively lower in BARI Hybrid Tomato varieties compared to local cultivar.

On-Farm trial of BARI developed summer hybrid tomato variety

An on-farm trial was conducted at Narail, Comilla and Pabna during Kharif, 2013-14 to evaluate the performance of BARI developed summer hybrid tomato in farmers' field. Two BARI developed hybrid varieties viz. BARI Hybrid Tomato 4 and BARI Hybrid Tomato 8 were evaluated in the study. The trial was laid out in RCB design with 5 dispersed replications. The unit plot size was 10 m x 1.2 m with a spacing of 60 cm x 40 cm. BARI Hybrid Tomato 8 performed better in Narail and Pabna whereas BARI Hybrid Tomato 4 produced higher yield in Comilla**.** Farmers expressed their satisfaction with the higher yield, single fruit weight and attractive color of both the summer hybrid tomato varieties. They are interested to cultivate these varieties in future.

On-Farm trial of BARI developed capsicum variety

The experiment was carried out in the farmers' field at Shibpur, Narsingdi during, Rabi 2014-15 to evaluate the performance of capsicum varieties. Three varieties viz. BARI Mistimorich 1, Yolo Wonder and California Wonder were evaluated in the study. The unit plot size was 4m x 1m. Seedlings were transplanted in the main field which was kept under nylon net and at night capsicum plants were covered with polythene sheet to prevent cold injury as well as proper growth and development with a spacing 50cm x 40cm. Seedlings were raised under nylon net in the seed bed and were transplanted on 23rd December 2014. The crop was harvested from 30 March to 20 April 2015. The highest yield was found in California Wonder (14.13 t ha^{-1}) and the lowest in Yolo Wonder (11.29 t ha^{-1}). Farmers' were very impressed with the performance of capsicum varieties.

Adaptive trial of onion varieties

The experiment was conducted at Mujibnagar, Meherpur during Rabi season of 2014-15 to observe the performance of BARI developed onion variety, BARI Piaz 4 against local (Suksagar). It was laid out in RCBD design with six dispersed replications. Unit plot size was 400 m^2. Purple blotch disease was controlled by spraying of Rovral and Folicur. The crop was harvested at 24 February-4 March, 2015. Bulb yield was higher in BARI Piaz 4 (45.67 t ha^{-1}) compared to local (45.33 t ha^{-1}). Farmers preferred BARI Piaz-4 due to higher yield.

On-Farm validation of garlic varieties

A field trial was conducted at Bogra, Pabna, Kushtia, Faridpur, Bhola, Kishoreganj, Sylhet, Comilla and Bandarban during Rabi, 2014-15 to evaluate the performance of modern garlic varieties under farmers' field condition. Two varieties of garlic viz. BARI Roshun-1, BARI Roshun-2 along with Local were tested whereas in Bogra the tested varieties were BARI Roshun 1, BARI Roshun 2, BAU Roshun-1, BAU Roshun-2 and local. The experiment was laid out in RCB design with six replications having plot size 5 m × 6 m with an inter plot distance of 0.75 m. The seeds (clove) were planted at a spacing of 20 cm ×10 cm. BARI Roshun 2 gave the highest marketable yield in all locations whereas

BARI Roshun-1 performed better in Kushtia and BAU Roshun-2 in Bogra. Farmers' preferred garlic var. BARI Rashun-2 due to its higher yield and short duration and well fitted in the existing cropping pattern in all the locations except Bogra where BAU Rashun-1 performed better.

Adaptive trial of turmeric varieties in coastal area

The experiment was conducted at MLT site, Satkhira during 2013-14 to evaluate the performance of turmeric varieties in coastal area of Satkhira. Four turmeric varieties viz. BARI Holud-1, BARI Holud-2, BARI Holud-3 and BARI Holud-4 were evaluated in the study. The experiment was laid out in RCBD with three replications. The unit plot size was 4.2m x3.0 m. The crop was harvested on February 20, 2014. The highest yield was recorded from BARI Holud 4 (36.67 t ha^{-1}) and the lowest in BARI Holud-1 (21.32 t ha^{-1}). Farmers of the area showed their interest with turmeric var. BARI Holud 4 for its higher yield potentiality and tolerance to diseases.

On-Farm trial of black cumin at Char land

An on-farm trial was conducted at the char land of Bhuapur, Tangail, Gobindhagonj, Gaibandha and Malancha, Melandah, Jamalpur during rabi 2014-15 to evaluate the performance of BARI Kalozira-1 and to popularize it among the farmers. BARI Kalozira 1 performed better in all tested location against the local variety. Black cumin is a new crop at the char land of Bhuapur. Farmers opined that they are interested to grow BARI Kalozira-1for its higher yield potentiality. They want to get available seeds of BARI Kalozira-1during growing season. Similar response was also found from the farmers of Gaibandjha and Jamalpur.

On-Farm trial of coriander at Char land

An experiment was conducted at the Char land of Tangail, Gaibandha and Jamalpur during Rabi 2014-15 to evaluate the performance of BARI Dhonia-1 under farmer's field condition and to popularize it among the farmers. BARI Dhonia-1 performed better yield all the three locations against the local variety. Farmers are interested to grow coriander var. BARI Dhonia 1 for its higher yield potentiality compared to local variety. Farmers opined that fresh leaf used in the curry was tastier and smell good than local variety.

On-Farm trial of fenugreek at charland

A field trial was conducted at the farmer's field of Tangail, Noakhali, Jamalpur and Gaibandha during Rabi, 2014-15 to evaluate the performance of fenugreek variety in char areas and popularize them among the farmers to promote their adoption. BARI developed high yielding fenugreek varieties viz. BARI Methi 1 and BARI Methi 2 were tested against local variety. The experiment was laid out in a RCB design with eight dispersed replications. The size of unit plot was 3m × 1.5m and unit plots were separated by 0.75m spacing. Seeds were sown @ 12 kg ha^{-1} in lines with maintaining the spacing of 25 × 10 cm. BARI Methi 2 gave the highest yield in all locations. Farmers were interested to grow fenugreek var. BARI Methi 1 and BARI Methi 2 for its higher yield potentiality. They demanded seed of BARI Methi 2 during the sowing period.

Adptive trial of gladiolus varieties at farmers field

A trial was conducted at Rajshahi and Rangpur during 2014-15 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 400 m^2 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 used. The spikes were harvested when lower 2-3 florets showed their blushes of colour. Gladiolus-3, BARI Gladiolus 4 and BARI Gladiolus 5 showed better performance and produced higher yield than BARI Gladiolus-1. The demand of BARI Gladiolus-3 and BARI Gladiolus-5 was higher in Rajshahi depending on the consumer's choice, early flowering and economic value. The demand of BARI Gladiolus-3 and BARI Gladiolus-4 was higher in Rangpur. At Rajshahi, farmers were interested to grow BARI Gladiolus-3 and BARI Gladiolus-5 due to their higher yield potentialities, shorter duration and economic profit. Farmers of Rangpur were interested to cultivate BARI Gladiolus 3 and BARI Gladiolus 4 due to their higher yield potentiality and better market price over check variety.

Adaptive trial of mustard varieties

The experiment was conducted at Bhola during Rabi 2014-15 under AEZ-18 to screen suitable variety of mustard for Bhola region. BARI developed two Brassica juncia varieties namely, BARI Sarisha 11 and BARI Sarisha 16 and two Brassica campestris varieties namely, BARI Sarisha 14 and BARI Sarisha 15 and one local check were tested in the study. Unit plot size was 8m × 5m. Seeds were sown in line maintaining 30 cm row spacing. Plant to plant spacing 4-5 cm was maintained after thinning. Seeds were sown on 04 December 2014. BARI Sarisha 11was harvested on 21 March 2015, BARI Sarisha 16 on 19 March 2015, BARI Sarisha 14 on 26 February 2015, BARI Sarisha 15 on 24 February 2015 and local variety on 19 February 2015. All the tested varieties performed satisfactory seed yield even in late sowing condition. BARI Sarisha 16 produced higher seed yield (1.77 t ha^{-1}) than BARI Sarisha 11 (1.65 t ha^{-1}). Among B. campestris BARI Sarisha 15 produced the highest seed yield (1.59 t ha^{-1}) which was statistically identical to BARI Sarisha 14 with short duration. Local variety gave the lowest seed yield (1.10 t ha^{-1}). Days to maturity are not an important factor as they grow T. aus rice after mustard. Some farmers preferred yellow seeded varieties as it contains higher oil than brown seeded varieties. Considering seed yield and other characters farmers preferred BARI Sarisha 14, BARI Sarisha 15 and BARI Sarisha 16.

Adaptive trial of mustard varieties in rainfed condition

An adaptive trial of mustard varieties was carried out at Katlamari, Bhaluka during rabi 2014-15 to evaluate the performance of different mustard varieties under low water condition in the farmer's field. BARI Sarisha 14 and BARI Sarisha 15 were tested in this study. It was laid out in RCB design with six dispersed replications. Unit plot size was 8m x 5m. Seeds of BARI Sarisha 14 and BARI Sarisha 15 were sown on 06 November2014 and 16 November2014, respectively. BARI Sarisha 15 gave the highest yield (1.35 t ha^{-1}) whereas BARI Sarisha 14 produced the lowest yield (1.25 t ha^{-1}).The farmers were interested to grow BARI Sarisha 14 and BARI Sarisha 15 for higher yield. Farmers' opined that these two varieties could be fit well in Mustard-Boro-T. Aman cropping pattern.

Adaptive trial of advanced lines of rapeseed

An experiment was carried out at Pushpapara, Pabna and Muradnagar, Comilla during Rabi 2014-15 to evaluate the performance of some advanced lines of short duration mustard varieties to find out the scope to fit in Mustard-Boro-T. Aman cropping pattern. Four lines viz. BC-2010-1, BC-2010-2, Nap-0733-1, Nap-0733-2 for Pabna and NAP-0717-2 for Comilla along with two varieties viz. BARI Sarisha 14 and Tori-7 was used as check for the trial. Seeds were sown on 6 and 10 November 2014 in lines maintaining line to line spacing 30 cm and plant to plant spacing 4-5 cm after proper thinning. The crop was harvested on 3-22 February and 18-27 January at Pabna and Comilla region. All lines produced higher seed yield and lower disease severity compared to Tori-7 and BARI Sarisha 14. The maximum seed yield was obtained from NAP-0733-1 (1.81 t ha^{-1}) followed by BC-2010-1 (1.71 t ha^{-1}), NAP-0733 (1.73 t ha^{-1}) and BARI Sarisha 14 (1.63 t ha^{-1}) in Pabna whereas in Comilla NAP-0717-02 line produced higher seed yield (1.66 t ha^{-1}). Tori-7 showed poor performance in both the locations. Farmers opined that the advanced lines NAP-0717-02 and NAP-0733-01 gave higher seed yield and less pest and disease infestation. The farmers of this location preferred these two lines and intended to cultivate in future.

On-Farm trial of sesame varieties

An on-farm trial was conducted at FSRD site, Jalalpur MLT site, Zakiganj Sylhet during Kharif-I, 2014 to evaluate the performance of BARI developed sesame varieties. Four varieties viz. BARI Til 2, BARI Til 3, BARI Til 4 and T-6 (check) were evaluated in this trial. The experiment was laid out in a RCB design with six replications. The unit plot size was 10m x 10m. Seeds were sown in rows 30 cm apart. Sesame seeds were sown on 11 to 14 March 2014. The crop was harvested at full maturity on 4 to 11 June 2014. The seed yield was adjusted to 8.5% moisture content. BARI Til 4 performed better in both locations.Farmer expressed their interest on BARI Til 4 due to its higher yield.

Adaptive trial of advanced lines of sesame

An on-farm trial was conducted at Kushtia, Faridpur, Khulna and Patuakhali during Kharif I 2015 to evaluate the performance of advanced lines of sesame in the farmers' field. The experiment was laid out in a RCB design with four replications. Four lines viz., Ses-9751, Ses-9768, Ses-05163, Ses-2010-01R and one variety (BARI Til-4) were used as check in this study. Unit plot size was 10 rows 4 m long with 30 cm x 5 cm spacing. The highest seed yield was recorded in BARI Til 4 in all locations compared to other lines/varieties. Farmers were interested about BARI Til-4. Among the four lines, Ses-9751, Ses-9768 and Ses-05163 produced reasonable yield. Farmers were not interested to cultivate line Ses-2010-01R due to poor germination rate, severe infestation of stem rot disease and white color seed coat. The local farmers showed interest on black color seed coat than red or whitish colored seed coat.

Adaptive trialof linseed varieties

An experiment was conducted at Sylhet, Noakhali and Patuakhalito select a suitable variety of linseed and to increase crop production with four different varieties i.e. BARI Tishi 1 (Nila), Tishi Noakhali (Local), Tishi Patuakhali (Local) and Tishi Zakiganj (Local). The experiment was laid out in a RCB with six dispersed replications. The unit plot size was 4m x 5m. Seeds of Tishi were sown in broadcast. BARI Tishi 1 produced highest yield in Noakhali and Patuakhali whereas Tishi Zakiganj local performed better in Sylhet. Farmers were impressed to observe the performance of BARI Tishi 1 and showed their interest for cultivation of this variety for higher yield in all locations. But marketing facilities of linseed are not available in Patuakhali.

Adaptive trial of BARI released groundnut varieties

An adaptive trial was conducted at charland of Trishal, Mymensingh during 2014-15 to evaluate the performance of groundnut varieties against local. BARI Chinabadam 8, BARI Chinabadam 9, Binachinabadam 4 and a local cultivar (Dhaka-1) were tested in the study. The experiment was laid out in RCB design with five compact replications. Unit plot size was 8m x 3m. Among the varieties, BARI Chinabadam-8 produced the highest nut yield (1.92 t ha^{-1}). Farmers preferred BARI Chinabadam 8 for its higher yield, bigger seed size and short field duration and higher market price.

Adaptive trial of BARI released lentil varieties

The experiment was carried out at Mymensingh, Kushtia and Satkhira during Rabi 2014-15 to evaluate the performance of lentil varieties and to promote their adoption among the farmers. BARI and BINA have developed lentil varieties along with local check were evaluated in the study. Seeds of local variety were collected from a progressive farmer. RCB design was followed with three dispersed replications. The unit plot size was 8m × 5m. Seeds were sown by broadcasting method. BARI Masur

6 provided highest yield in Kushtia and Satkhira whereas BARI Masur 7 performed better in Mymensingh. Farmers of Mymensingh and Satkhira preferred BARI Masur 7 and Kushtia and Sathkhira were BARI Masur 6.

Adaptive trial of lentil varieties under relay crop condition

The trial was conducted at the MLT site Kushtia during 2014-15 to select the suitable lentil variety for relay condition and to increase production and farmers income. The experiment was laid out in RCB design with six replications. BARI Masur 6 and BARI Masur 7 were used in the trial. The yield of BARI Masur 6 was higher than that of BARI Masur 7. Farmers accepted BARI Masur 6 as relay crop due to higher seed yield. They stored seed for next year cultivation.

Adaptive trial of BARI released chickpea varieties in Char land

A field trial was carried out in the farmer's field at Basunarasinghadia, Sadar, Faridpur during Rabi, 2014-15 to evaluate the performance of BARI released chickpea varieties. BARI Chola 3, BARI Chola 5, BARI Chola 9 and Faridpur local (check) were evaluated in the study. The experiment was laid out in a RCB design with three replications. The unit plot size was 5m x 4m. The seeds were sown in line maintaining row spacing of 40 cm and continuous placement of seed. Seeds were treated with Bavistin @ 40 kg ha^{-1} sown on 30 November 2014. The crop was harvested on 30 March 2015 (122 days). Among the tested varieties, BARI Chola 9 gave the maximum seed yield (1.90 t ha^{-1}) followed by BARI Chola 3 (1.75 t ha^{-1}) and lowest in local variety (1.38 t ha^{-1}). Farmers were interested to cultivate BARI Chola 9 for its higher yield and less pest infestation. Farmers informed that pest infestation was lower in BARI released varieties than Faridpur local.

Adaptive trial of blackgram varieties in Haor areas

A field trial was conducted at MLT site, Madhobpur, Sylhet during Kharif-I, 2014 to select suitable variety of blackgram. Three varieties viz. BARI Mash 1, BARI Mash 2 and BARI Mash 3 were evaluated in the study. The experiment was laid out in RCB design with six replications having plot size 5m x 4m. Seeds were sown in rows maintaining 30 cm spacing on 28-31 March 2014. The crop was harvested on 2-5 May 2014. The seed yield did not differ significantly among the varieties but higher yield was produced in BARI Mash 3 (1.15 t ha^{-1}). Farmers preferred BARI Mash 3 among the varieties. They stored seeds of the variety to cultivate in the next year.

Integrated Farming

Integrated farming for improving livelihood of resource poor farm households in a participatory approach

The integrated farming study was carried out at Plain land ecosystem- northern and eastern zone (FSRD site Pushpopara, Pabna; Lahirirhat, Rangpur; Hatgobindapur, Faridpur; Elenga, Tangail and Kusumhati, Sherpur) and Coastal and Rainfed ecosystem (FSRD site Rajakhali, Patuakhali; Hazirhat, Noakhali; Kadamshahar, Barind, Rajshahi and Jalalpur, Sylhet) during 2014-2015 to utilize available farm resources and to improve livelihood of the resource poor farm households. 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. Farmers obtained higher yield and economic return from their improved cropping pattern with improve variety(s). 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 190910 Tk 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. 19580-129650 Tk ha^{-1}).

Results of homestead production program revealed that intake of vegetable were markedly increased (271%) by all families included in this system.Average intake of fruits per year was also increased (131%) after intervention of the technology. Gross return (70%) and gross margin (196%) was increased due to deworming and vaccinaton program of cattle. Mortality of poultry reduced (76-90%) after vaccination. Moreover, farm yard manure (FYM) production and utilization were created a good impact among the farm family. Among the seasonal fish culture carp polyculture gave higher gross margin (Tk. 17389 pond^{-1}) at farmers' level. From off-farm activities, farmers also earned some extra money (Tk. 5258 household^{-1}). In coastal and rainfed ecosystem newly released high yielding crop varieties were also introduced through on farm validation program where farmers obtained higher crop yields and gross margin (Tk.27250-64145ha^{-1}). Seven improved cropping pattern trials were conducted in different location of which Soybean-T. Aus-T. Aman gave the highest productivity and economic return (Gross margin Tk 148100 ha^{-1}) at Noakhali. Vegetables production was increased maximum at Kadamshahar, Rajshahi (338%) and minimum at Jalalpur, Sylhet (200%) 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 (280%) remarkably. Average intake of fruits per year was also increased (168%) 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 196%. Duck rearing in the homestead at Patuakhali 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 (61%), consumed about 32% and distributed 8% among their neighbours, relatives and well-wishers of the produced fish. Average gross margin obtained per pond about Tk. 20813. 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 increase of consumption of vegetables and fruits from the homestead gardening. 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.

Socioeconomic Studies

Impact of hybrid rice and maize seed in cereal production system in Bangladesh

The study was undertaken on hybrid rice and maize seed production and marketing scenario, farmers' perception and efficiency of hybrid rice and maize producers. In first year, data of 20 seed dealers and 200 farmers was collected from Dinajpur and Sherpur district and analyzed. In addition, data of major 10 seed companies also collected and analyzed. More than four thousand tons of hybrid rice seed was imported by 10 seed companies in 2014-15 which was about 40% of total import of hybrid rice seed (about 10000 tons). All the seed companies sell their seed through distributors, seed dealers and retailers. Only BADC produce hybrid rice seed but it is about 10 percent of total import. Farmers' gross margin was increased by 22 percent in Dinajpur and 28 percent in Sherpur over HYV rice seeds. The stochastic frontier production function (SFA) indicated that the parameter γ and σ^2 are significant which means that inefficiency effects are present. 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 rice seed.

Baseline report of Pirojpur-Gopalganj-Bagerhat integrated agricultural development project

A baseline survey was conducted at all the 21 upazilas of Pirojpur, Gopalganj and Bagherhat districts to know the present status of different crop production, to generate some baseline standpoints/indicators for future impact assessment and to explore the constraints to implement and opportunities for further expansion. The survey was conducted during July to December 2012. The study revealed that majority of the sample farmers' cultivated local variety of crops with applying lower dose of recommended fertilizers hence receiving lower level of yields for most of the crops. The common constraints mentioned by the farmers were lack of improved variety and seed, lack of knowledge about new crop variety and technology, insect pest infestation, low yield of crops, high price of labour and irrigation, lack of institutional credit etc.

Strengthening simulation approaches for projecting and managing climate risks in Dinajpur district of bangladesh

The study was carried out to examine the impact of climate change in rice-wheat systems farmers' livelihood in Dinajpur region and benefit of adaptation. Tradeoff analysis for multidimensional impact assessment (TOA-MD) model was used with a combination of simulated baseline production and future simulated yield using Decision Support Systems for Agrotechnology Transfer (DSSAT) and Agricultural Production Systems SIMulator (APSIM) in rice and wheat production system. Five different climate scenarios of Global Circulation Models (GCMs) was considered. Even though the magnitude and the impact of different GCMs differs, the projections shows to have a negative economic impact between 50 and 82 percent and not able to cope. Northwest region is likely to be affected by climate change and has high levels of vulnerability due to limited access to alternative livelihood activities other than farming. Simulation results show no economic gains from wheat cultivation but rice cultivation shows increased yield due to adding productivity trend. Therefore, an adaptation package for 50 mm additional irrigation water for wheat cultivation is likely to be an appropriate strategy for adapting to climate change. This has a positive impact on projected per capita income gains of about 2.05 percent and reduction of poverty rate by about 1.99 percent.

16 ENTOMOLOGY

Vegetables

Brinjal

Development of a management approach against sucking insect pests of brinjal

The experiment was conducted in the research field of BARI, Gazipur during 2014-15. Brinjal seedlings of BARI Begun 8 were transplanted in plots of 4m x 5.5m. The experiment was laid out in RCBD having three dispersed replications and 6 treatments including control. Manures and fertilizers were applied as per recommended dose. Common agronomic practices were followed to raise a good crop. The treatments were assigned as T_1= Azadirachtin (Bioneem plus 1EC @ 1 ml/L of water) (4 sprays at fortnight interval starting from the first initiation of the pest attack) + installation of white & yellow sticky traps each @ 40 traps/ha;T_2= Potassium salt of fatty acid (Fytoclean 40 EC @ 5 ml/L of water) (4 sprays at fortnight interval starting from the first initiation of the pest attack)+ installation of white & yellow sticky traps each @ 40 traps/ha; T_3= Diafenthiuron (Polo 500SC @ 1 ml/L of water) (4 sprays at fortnight interval starting from the first initiation of the pest attack)+ installation of white & yellow sticky traps each @ 40 traps/ha;T_4= Alternate spraying of Bioneem plus 1EC and Polo 500SC + white & yellow sticky traps; T_5= Alternate spraying of Fytoclean 40 EC and Polo 500SC + white & yellow sticky traps and T_6= Untreated control.

Results indicated that White & yellow sticky traps + Diafenthiuron (Polo 500SC) treated plots showed significantly lowest jassid (1.96/five leaves), thrips(1.07/five leaves) and whitefly (3.62/five leaves) population. However, installation of white and yellow sticky traps in combination with spraying Polo 500SC @ 1 ml / litre of water appeared as the best approach providing highest yield (16.77t/ha) and Marginal Benefit Cost Ratio (3.11).

Tomato

Development of bio-rational based integrated management package(s) against whitefly and borer pests of summer tomato

The experiment was conducted at BARI, Gazipur during summer 2015 to evaluate the effectiveness of some management packages against whitefly and borer pests of summer tomato. Tomato seedlings (variety: BARI hybrid tomato 4)) were transplanted in the field on 6 June 2015 maintaining plant spacing of 60cm and row spacing of 60cm. The experiment was laid out in RCBD having 5 treatments including an untreated control with three dispersed replications. The treatment packages were:

T_1 = a) Seed treatment with Imivax (Imidacloprid) 48 FS@ 10 ml/ kg seed, b) Sex pheromone traps for *Spodoptera litura* and *Helicoverpa armigera* each @ 40 traps/ha starting from 7 days after transplanting (DAT) and continued until the last harvest, c) Spraying of Azadiractin 1EC (Bioneem plus) @ 1ml/L of water (Four sprays were done at 15 days interval starting from 7 DAT)

T_2 = a) Seed treatment with Imivax (Imidacloprid) 48 FS@ 10 ml/ kg seed b) Sex pheromone trapping for *Spodoptera litura* + *Helicoverpa armigera* (as in T_1) c) Spraying of Spinosad 45 SC (Tracer) @ 0.4ml/L of water (as in T_1)

T_3 = a) Seed treatment with Imivax (Imidacloprid) 48 FS@ 10 ml/ kg seed b) b) Sex pheromone trapping for *Spodoptera litura* + *Helicoverpa armigera* (as in T_1) c) Spraying of Spinosad 45 SC (Tracer) @ 0.4ml/L of water (Two sprays were done at 15 days interval starting from 7 DAT) d) Single spray of both SNPV@ 0.2 g/ L of water & HNPV @ 0.1 g/ L of water (during initiation of fruit borer attack)

T_4 = Farmers practice: a) Spraying of Admire (Imidacloprid) 200SL @ 0.5ml/L of water (Started from 7 DAT, continued at 7days interval up fruit initiation), b) Spraying of Voliam flexi (Chlorantraniliprole + Thiamethoxam) 300 SC@ 0.5ml/L of water (Started from fruit initiation, continued at 7days interval up to last harvest)

T_5 = Untreated control

The management package (T_3) comprising of seed treatment with Imivax (Imidacloprid) 48 FS + Sex pheromone traps for *Spodoptera litura* & *Helicoverpa armigera* + spraying Spinosad 45 SC + spraying of SNPV & HNPV appeared to be the best management package in view of lowest whitefly infestation, ToLCV infection and fruit borer infestation and highest yield. Consequently, the highest marginal benefit cost ratio (11.53) was also obtained from this package.

Cabbage

Development of bio-rational based integrated management packages for the major insect pests of cabbage

The experiment was conducted in the experimental field of Entomology Division, BARI, Gazipur during 2014-15 to develop an IPM package for insect pests of cabbage grown under different planting dates This study was started from October 2014 and continued till February 2015. A distance of 200 m^2 was maintained between the treatments plots and the untreated control plots. Cabbage was transplanted twice, 1^{st} transplanting on 2nd October 2014 and harvesting of those transplanted cabbage heads continued till 31 December 2014, 2^{nd} transplanting on 27 November 2014, which continued till 25 February 2015. There were five treatments and three replications and the experiment was set following RCB design. The five treatments were: T_1= IPM package 1: Hand picking + Pheromone trapping for *Spodoptera litura* + spraying Bt (EG 7841) @ 2g/3L of water at 10 days interval); T_2= IPM package 2: Pheromone trapping for *S. litura* + spraying Bt (EG 7841) @ 2g/3L of water at 10 days interval); T_3= IPM package 3: Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3L of water at 10 days interval) + SNPV @ 0.2g/L of water of water at 10 days interval ; T_4= Farmers practice : Spraying of cypermethrin (Ripcord 10 EC) @ 1ml/l of water at 7 days interval; T_5= untreated Control.

Cabbage planted during October and harvested in December was infested during the early part with leaf-eating caterpillars. The head infestation was 2.09-4.33% in the IPM treated plots. Significantly higher yields were also recorded in the treated plots than the farmers practice. Very low infestation was observed in the November 2014 transplanting, which was harvested till February 2015. The head infestation was 1.33-1.62% in the IPM treated plots. Significantly higher yields were also recorded in the IPM treated plots than the untreated control plots. Healthy cabbage yield was also significantly higher in the IPM plots than the farmers' practice & untreated plots.

The differences in infestations between two planting times happened due to variation in temperature. Average temperature was within 21.22-26.45 ^{0}C during the head formation stage of October planting while it was 17.29-20.07 ^{0}C during the head formation stage of November planting. Due to low temperature the prevalence of insect pests were very low in the November planting.

Ridge Gourd

Management of leaf miner in ridge gourd

The experiment was carried out at RARS, Jamalpur during 2014-15 cropping season. There were five treatments viz.T_1= Sanitation+ azadirachtin (Bioneem plus 1EC)@ 1ml/L of water, T_2=Cover the soil under infested plants with plastic mulches+ spraying of spinosad (Tracer 45SC) @ 0.4 ml/L of water,T_3= Spraying of azadirachtin (Fytomax 3EC) @ lml/L of water, T_4= Spraying of acetamiprid (Tundra 20SP) @ 1g/L of water and T_5= Untreated control. The experiment was laid out in RCB design with three replications. The treatments were applied at seven days interval after initiation of leaf miner infestation.

Different treatments showed the significant effect on the infestation of leaf miner and the lowest infestation was recorded from the plots treated with plastic mulch + spinosad (Tracer 45SC) treated plots which was statistically similar to sanitation + azadirachtin (Bioneem plus 1EC) treated plots. Consequently, the highest marginal benefit cost ratio (MBCR) (6.30) was also obtained from plastic mulch + spinosad (Tracer 45SC) treated plots which was closely followed by sanitation + azadirachtin (Bioneem plus 1 EC) treated plots (6.29) .

Chilli

Evaluation of different exotic chilli germplasms against thrips and mites

The experiment was conducted at Bangladesh Agricultural Research Institute (BARI), Gazipur during 2015 to evaluate 3 exotic chilli germplasms against thrips and mite. Three promising chilli genotypes received from AVRDC (The world vegetable centre), Taiwan and a commercial variety BARI Morich 1 (used as check) was planted on March 31, 2015. The experiment was laid out in RCBD with 3 replications. The unit plot size was of 6 x 2.5 sq-m. The recommended agronomic practices were followed to raise the crop. No insecticide was applied during the entire cropping season.

The mean thrips and mite population indicated that all the chilli germplasms were found promising in view of least pest population. The germplasm PBC 145 recorded significantly the lowest population of thrips (2.39/twig) followed by AVPP 1236 (2.51/twig) and AVPP 1212 (2.82/twig). However, thrips population did not vary significantly among PBC 145, AVPP1212 and AVPP 1236. Significantly the highest population of thrips (5.20/ twig) was noticed in the check variety BARI Morich 1.

More or less similar trend was observed in case of population of mites in different germplasms. Significantly the lowest population of mite (0.65 / five leaves) was noticed in AVPP 1236 which was followed by AVPP 1212 (0.82/ five leaves) and PBC 145(0.92/ five leaves), although, mite population did not vary significantly among the tested germplasms. Significantly the highest population of mites (3.82/ five leaves) was noticed in the check variety BARI Morich 1.

From this study it could be concluded that, all the studied chilli germplasms viz. AVPP 1212, AVPP 1236 and PBC 145 were found promising in view of least thrips and mite attack.

Development of management approach against sucking pests attacking chilli

The experiment was conducted in the research field of Entomology Division, BARI, Gazipur during 2014-15. Chilli seedlings were transplanted in a plot of 4m x 5.5m. The experiment was laid out in RCBD having three replications and 6 treatments including control. Manures and fertilizers were applied as per recommended dose. Recommended agronomic practices were followed to raise a good crop.

The treatments were assigned as T_1= Azadirachtin (Bioneem plus1EC) @ 1ml/L of water (4 sprays at fortnight interval starting from the first initiation of pests attack) + installation of white sticky traps @

40traps/ha; T_2= Fytoclean 40EC (potasium salt of fatty acid) @ 5ml/L of water(4 sprays at fortnight interval starting from the first initiation of pests attack) + installation of white sticky traps @ 40traps/ha; T_3= diafenthuron (Polo500SC) @ 1ml/L of water (4 sprays at fortnight interval starting from the first initiation of pests attack) + installation of white sticky traps @ 40traps/ha; T_4=4 sprays at fortnight interval starting from the first initiation of pests attack alternate spray of Bioneem plus1EC and Polo 500SC + installation of white sticky traps @ 40traps/ha; T_5= 4 sprays at fortnight interval starting from the first initiation of pests attack alternate spray of Fytoclean40EC and polo500SC + installation of white sticky traps @40traps/ha; and T_6= Untreated control.

The management approach comprising of sticky white trap + diafenthuron (Polo 500SC) @ 1ml/L of water appeared as the best management option against aphids and thrips recording the lowest thrips and aphids population (21.46/five twigs and 11.08/five twigs, respectively). The highest yield increase (32.69%) over control as well as the highest benefit cost ratio (BCR) (0.56) was also achieved from sticky white trap along with Polo 500SC treated plots.

Fruits

Mango

Development of insecticide based management package against mango hoppers, (*Idioscopus* spp.)

Studies were conducted at the mango orchard of HRC, BARI, Gazipur, Bangladesh during 2015 mango season in a randomized complete block design (RCBD) with 4 treatments and 3 replications. One mango tree was considered as one replication of a treatment. Around 15 year old mango trees were used in these treatments. Each treatment was applied twice as a full cover spray on mango trees from the ground with the help of a high volume and high pressure power sprayer, the first application within 10 days of flowering and the second at pea stage of the fruit growth (after 30 days of the first application). Each insecticide was used at a pre-determined single dose. The treatments were: T_1 = Imidacloprid (Confidor 70WG) @ 0.2g/litre of water, T_2 = Lambda cyhalothrin (Karate 2.5 EC) @ 1.0ml/litre of water, T_3 = Cypermethrin (Ripcord 10EC) @ 1.0ml/litre of water, and T_4 = Untreated control with water spray only. The fungicide, mancozeb (Indofil M-45) @ 2.0g/litre of water was added in all the treatments during spray applications.

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 10 EC > Karate 2.5 EC.

Development of bio-rational based management approach against mango leaf hopper, (*Idioscopus* spp.)

The experiment was conducted at the mango orchard of HRC, BARI, Gazipur during the mango season 2015 in a randomized complete block design with 4 treatments and 3 replications. One mango tree was considered as one treatment/replication. Around 15 year old mango trees were used for the study. The treatments were assigned as T_1= Two sprays of *Beauveria bassiana* (microbial pesticide) @ 5.0g/litre of water-first spray within 10 days of flowering and second at pea stage of fruit growth, T_2 = Spraying of *B. bassiana* @ 5.0g/litre of water within 10 days of flowering and spraying of Bioneem plus @ 1.0ml/litre of water + Indofil M-45 @ 2.0g/litre of water at pea stage of fruit growth, T_3 = Two sprays of Bioneem plus (Azadirachtin) @ 1.0ml/litre of water + Indofil M-45 @ 2.0g/litre of water-first spray within 10 days of flowering and second at pea stage of fruit growth and T_4= Untreated control with water spray only.

The spraying of *Beauveria bassiana* @ 5.0g/litre of water within 10 days of flowering and spraying of Bioneem 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 leaf hopper and provided the highest MBCR (3.42) and fruit retention (235.5%) at mature stage over untreated control.

Pesticide Toxicology

Determination of pre-harvest interval for dimethoate and quinalphos in different vegetables and spice crops

The study was undertaken to determine the per-harvest interval (PHI) for dimethoate in chilli, yard long bean and red amaranth; quinalphos in brinjal, chilli, cabbage, stem amaranth and red amaranth depending on Maximum Residue Limit (MRL) set by FAO/WHO. The standard for dimethoate and quinalphos were obtained from Sigma-Aldrich Laborchemikalien, Gmbh P O Box-100262 D-30918, Seelze, Germany via Bangladesh Scientific Pvt. ltd. Dhaka, Bangladesh. Standards of both the insecticides contained 99.6% purity. Two supervised field trials were conducted and sprayed with the recommended dose (2ml/L of water) of dimethoate and quinalphos. Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 days after spray (DAS). The quantities were above MRL up to 7 DAS for dimethoate in red amaranth; 6 DAS for dimethoate in chilli and yard long bean; 7 DAS for quinalphos in brinjal and chilli; 6 DAS for quinalphos in cabbage, red amaranth and stem amaranth. At 9 DAS, no residue was detected from any of the tested samples except quinalphos in brinjal and chilli. The determined PHI were 8 DAS for dimethoate in red amaranth; 7 DAS for dimethoate in chilli and yard long bean; 8 DAS for quinalphos in brinjal and chilli; 7 DAS for cabbage, red amaranth and stem amaranth.

Residue analysis of different insecticides in dry fish collected from different markets

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The present study was undertaken to detect and quantify the left over residue of twenty organochlorine insecticides (DDT, Aldrin, Dieldrin, Endrin and Heptachlor etc.) in ten different types of dry fish samples like Loitta, Kanchki, Mola, Paysha, Chanda, Churi, Chingri, Shidhol, Hangor & Chepa. These samples were collected from eight region of Bangladesh like Chittagong, Khagrachori, Rangpur, Bogra, Dinajpur, Mymensingh, Dhaka and Rajshahi for the comparison between the detected residue level with maximum residue level (MRL) set by Australian Pesticides and Veterinary Medicins Authirity. A total of 60 samples of dry fish were collected and analyzed for the quantification of insecticide residues. Among them, 20 samples were contaminated with detectable residue. Out of 20 contaminated samples, 18 samples were contaminated with Endrin (0.05-0.18ppm). Among 18 samples, 9 samples were in above MRL (0.1ppm). Most of the Loitta, Kanchki, Mola, Paysha and Chepa were contaminated with Endrin. Heptachlor epoxide (0.07ppm) and Endrin ketone (0.09ppm) also detected in cheapa and shidhol dry fish samples. Most of the dry fish samples content residue which was collected from Bogra location. Dry fish samples of Churi, Chingri, Hangor and Chanda did not show any detectable organochlorine residue.

Decontamination of pesticide residues from vegetables

The study was conducted to evaluate the effect of different decontaminating solutions/ processes in the removal of organophosphorus pesticide residues (diazinon, malathion, fenitrothion, quinalphos and chlorpyrifos) in brinjal, tomato, bean, cucumber and chilli at Pesticide Analytical Laboratory, of Entomology Division, BARI, Gazipur during 2014-15. Estimation of residues was done using Gas Chromatograph equipped with Flame Thermionic Detector.

Different treatments (processes for decontamination) were assigned as:

(1) Washing with Running Water (WRW), (2) Dipping in Normal Water (DNW), (3) Dipping in 2% Common Salt water Solution (DSW), (4) Dipping in 2% Vinegar water Solution (DVW), (v) Dipping in 1% Turmeric powder solution (DTW), (6) Dipping in Luke warm water (DLW), (7) Washing with Detergent powder (WDP), (8) Cooking until soften (Cooking), (9) Peeling (Peeling), (10) Washing with running water+dipping in normal water +cooking (WRW+DNW+Cooking), (11) Dipping in normal water+dipping in 2% salt solution+cooking (DNW+DSW+Cooking), (12) Washing with detergent+dipping in 2% common salt solution+cooking (WDP+DSW+Cooking), and (13) Dipping in normal water+dipping in 2% salt solution+peeling (DNW+DSW+Peeling).

The results clearly indicated that washing with detergent + dipping in 2% common salt solution + cooking (WDP +DSW + Cooking) reduced pesticide residues completely (100%) from tomato, bean and brinjal while 91% and 69% pesticide reduction occurred in cucumber and chilli, respectively. This study helped to standardize simple cost effective strategies to eliminate harmful pesticides from vegetables which could be practiced by home makers.

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Fungal Disease

Study the seed health status of maize

Thirty three samples of farmer stored maize seed were collected from different locations of Rangpur, Sherpur, Mymensingh, Jamalpur, Comilla, Manikgonj and Bogra districts of Bangladesh for testing their health status. *Alternaria alternata, Aspergillus flavus, Aspergillus niger, Fusarium* sp., *Ustilago maydis, Penicillium* sp. and *Rhizopus stolonifer* were found to be associated with maize seed. Among them the most predominant was *Penicillium* sp. which was associated with 95% seed samples in Sadar, Ganggachara followed by *Fusarium* sp (85%) in Dabipur-1, Taragonj and *Rhizopus stolonifer* (85%) in farmers saved seed of Pourobazar Rangpur. The least incidence was 5%. *Ustilago maydis* (35%) was found in only the seed sample from Vutka, Ganggachara and Rangpur. The 100% germination was recorded from BADC seed samples of Sadar Jamalpur which followed by Bogra (95%). No germination of seed was observed from Moddhobuspur, Ganggachara, Sadar Ganggachara and Paglapir, Taragonj in Rangpur district and Rainogor, Bogra district.

Assessment of seed borne pathogen of sesame in Bangladesh

A total of twenty one farmers stored sesame seed samples were collected from different locations of Rangamati and Mymensingh District 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 species were found to be associated with the sesame seeds. Among them the most predominant was *Aspergilus niger* which is associated with 48.1% seed samples followed by *Aspergilus flavus* (24.8%). A least incidence of 0.8 % was observed in case of *Epicochum*. The highest percent of seed germination (96.8%) was recorded from Rajostholy, Rangamati which followed by Bangalkhaly, Rangamati while the lowest germination was recorded from Bangalkhaly and Rangamati.

Effect of plant growth stage on development of stemphylium blight disease in lentil

The experiment was conducted at research field of BARI, Gazipur. Stemphylium blight disease susceptible lentil variety BARI Masur-1 was sown on five different dates viz. 10 Nov., 20 Nov., 30 Nov. 10 Dec. and 20 Dec. of 2014 with three replications. Lentil plant debris was spread two times over the plots to boost up the inoculum pressure in the field. The first appearance of the disease was observed after 65 days in two sowing dates i.e. 10 Nov. and 20 Nov. 2014 sown plot with lentil plant age of 65 and 55 days respectively. At that time the lentil plants of both the plots were in flowering stage. After 10 days the 30 Nov. 2014 sown plot was also infected by the stemphylium when the plants of this plot started flowering. A few infections were also observed in 10 Dec. 2014 sown plots at flowering stage. No infection was observed in 20 Dec. 2014 sown plots.

Identification of diseases of cumin, black pepper and cardamom

The experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during 2014-15 to identify different diseases of cumin, black pepper and cardamom. Diseased plant samples having typical symptoms were collected from the different experimental fields for Identification of different diseases of cumin, black pepper and cardamom. Data on Cumin diseases were recorded from different Cumin lines. Among the Cumin lines, the lowest wilt incidence (12.00%) was observed in Cumin line CN 16 and the highest incidence (27.33%) was recorded in Cumin line CN 17. Significantly the lower leaf blight severity (1.20%) of Black pepper was recorded from month of May and the highest severity (8.40%) was observed in month of November. Algae leaf spot/red rust severity of Black pepper ranged from 1.30-8.30% while the lowest severity was obtained from month of March and the highest severity was obtained from month of October. Leaf spot/blight disease severity of Cardamom ranged from 8.00-25.60% while the lowest severity was obtained from month of May and the highest severity was obtained from month of October.

Yield loss assessment of potato due to late blight infection at different ages under natural condition

An experiment was undertaken to observe the yield loss of potato due to infection of late blight caused by *Phytophthora infestans* at different stages of plant growth at RARS, Burirhat, Rangpur during Rabi season of 2014-15. Seeds of susceptible variety BARI Alu 7 (Diamant) were planted on 10th, 20th, 30th November, 10th and 20th December 2014 following Split plot design having three replications. In every date of planting, two treatments or plots were planted. Secure 600 WG (Phenamidon – 10% and Mancozeb – 50%) @ 1g/L water was sprayed in one plot in each date of planting and another one was free from fungicide spray. Disease severity i.e. % leaf area infected was found increasing with the delay in planting time up to 20th December 2014. In 10th November 2014 planting, reduction of yield was 11.82% compare with fungicide treated plot and this reduction value was increasing with the delaying of planting and it was up to 189.36% in 20th December planting.

Study on botrytis blight development in gladiolus at different sowing dates in Godkhali, Jhikargasa

The experiment was conducted at Panisara, Godkhali, Jessore to Study on the effect of Botrytis blight development of Gladiolus. There were six planting time such as 08th November, 15th November, 22^{h} November, 29th November, 6th December, and 13th December used as treatment. In this experiment, the highest disease score (3.70 and 3.87 respectively) and severity/PDI (83.33 and 85.55) were recorded from the plots where the corms were planted at the date of 15th November and 22th November due to getting favorable disease development environment (Maximum temperature, Minimum temperature and humidity) for long time; from early vegetative to maturity or harvesting time. Among the planting date, 29th November 2014, showed better performance for all the vegetative characters such as the highest plant height (113.3cm), the highest flower length (45.70cm), the highest number of floret (12.53) with moderate disease scale and disease severity (2.6 and 80% respectively).

Screening of bush been lines/varities against foot rot disease caused by S*clerotium rolfsii*

Eight Bush bean lines and varieties were evaluated to observe their reaction against foot rot causing pathogen *Sclerotium rolfsii* at pot house of plant pathology division, BARI, Gazipur. Among 9 lines/varieties of bush bean, most of them showed highly susceptible (HS) reaction except L4 which showed Susceptible (S) reaction.

Screening of tomato lines/verities against early blight disease under natural field condition

An experiment was conducted in the research field of Plant Pathology Division, BARI during 2014-15 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 showed highly resistant reaction. Among the others, five lines were seems to be resistant and twelve lines/varieties were moderately resistant.

Evaluation of chilli germplasm against *Rhizoctonia solani*

An experiment was conducted in the research field of PGRC, BARI during 2014-15 cropping season to evaluate the performance of chilli lines for searching of wilt disease resistant variety. Sixty five chilli germplasm were used. Sixteen chilli germplasms showed highly resistant reaction. Among the others, eighteen germplasm were seen to be resistant and seventeen germplasm were moderately resistant.

Screening of lentil lines against stemphylium blight disease under inoculated condition

The experiment was conducted at BARI, Gazipur. Two set of lentil entries were evaluated against stemphylium blight disease in this trial. Set 1 was comprised with eight lentil test entries viz. BD-3807, BD-3943, BD-4053, BD-4 I34, LRIL-21-36, LRIL-22-36, LRIL-22-198 and LRIL-21-5888 which was selected from the previous years' trial were used in this experiment. Set 2 was included 10 lentil entries viz. 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. A susceptible check variety BARI masur-1 was used in both the sets. In set 1, lowest (1.33) stemphylium blight disease score and highest (1035 kg/ha) yield was recorded in BD-4053 and the highest (5.00) disease score with lowest (751.00 kg/ha) yield was recorded in the check variety BARI masur-1. In set 2, lowest (1.33) stemphylium blight disease score and highest (1220 kg/ha) yield was recorded in LR-9-25 and the highest (5.00) disease score with lowest (731.20 kg/ha) yield was recorded in the check variety BARI masur-1 which was statistically similar to the test entry ILL-5134.

Screening of potato varieties and germplasm against late blight disease

A total of twenty (20) germplasm/ varieties of potato including two resistant check varieties (BARI Alu-46 and BARI Alu-53) were evaluated against late blight disease under natural condition at RARS, Burirhat, Rangpur during 2014-15. Among the germplasms one line (Sarpomira) was selected as resistant which was found more resistant than the released resistant check varieties. The yield of Sarpomira was also higher than BARI Alu-46 and BARI Alu-53.

Effect of date of planting on purple blotch incidence of onion seed crop

Impact of different sowing dates against purple blotch of onion seed crop was conducted under natural field condition, at BARI, Joydebpur during 2014-15 using local variety. Out of 5 sowing date (04.12.14, 15.12.14, 25.12.14, 05.01.15 and 15.01.15) maximum disease index were recorded on 25.12.14, (80.00) date of sowing however maximum onion seed harvested on 15.12.14 ((4.93 kg) date of sowing. Maximum length and diameter of bulb were recorded on 15.12.14 date of sowing which were 3.22 cm and 2.68 cm respectively. In case of weight/bulb, the highest data was obtained from 25.12.14 date of sowing which was 53.40 gm.

Efficacy of different fungicides in controlling Sigatoka disease of banana

An attempt was made in the farmer field at Sagordighi and Garobazar of Tangail district during 2013-2014 to evaluate the efficacy of nine foliar fungicides viz. Avance 25 EC, G-Force 5EC, Kashatin 50WP, Care-2 300EC, Opal 7.5 EC, Lilivo 75WP, Suzala 10 EC, Zole plus 25EC and Tilt 250EC (check), against Sigatoka disease caused by *Cercospora musae* of banana. Mehersagar cultivar of banana was transplanted and the above mentioned fungicides were sprayed 4 times at 20 days interval. All fungicides gave significant control to the disease. Among the fungicides Lilivo, Opal, Kashatin and Tilt showed the best performance in reduction of disease severity.

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 against stemphylium blight disease of lentil caused by *Stemphylium botryosum*. The investigation was designed in RCB with three replications. The minimum disease score (1.0) was recorded from Rovral alone and alternate spray of Rovral and Secure treated plots and the highest (3.00) was observed in control plot. Among the four treatment combinations highest number of pods plant^{-1} (68.00) and highest grain yield (1437.00 kg ha^{-1}) was obtained from the plots sprayed with Rovral alone and alternately sprayed with Rovral and Secure. Lowest number of pods plant^{-1} (34.67) and grain yield (788.30 kg ha^{-1}) was obtained from the control plot.

Efficacy of new fungicides in controlling purple blotch disease of onion

An experiment was conducted in the field of Plant Pathology, Division, BARI during 2014-15 cropping season to find out the effectiveness of 15 new fungicides against purple blotch of onion. Among the fungicides significant disease reduction were showed by Betivo 75 WG, Benison 30 EC, Palki 75 WG, Tornado Fort 75WG, and L-vo 75 WG.

Efficacy of new fungicides in controlling anthracnose/die back of chilli

An experiment was laid out in the field of plant pathology, BARI, Joydebpur to evaluate the efficacy of nine fungicides in controlling die back disease of chilli during 2013-2014 cropping season. The design was RCBD having 3 replications using variety BARI Marich-1. The lowest diseases severity was found in Altime, Blequeen, Nativo and Propel treated plots.

Effect of fungicides in controlling wilt disease of cumin

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out the effective fungicides in controlling wilt disease of cumin. The treatments were five fungicides viz. Sunvit 50 WP @0.5%, Secure @0.02%, Rovral 50 WP @0.2%, Bavistin DF @0.25%, Provax 200 WP (0.25%) and one control (untreated). Cumin line CN 026 was used in the experiment. Wilt incidence ranged from 13.45 - 37.69%, while the lowest incidence was recorded In Bavistin treated plots which was statistically similar to Provax and Sunvit, and the highest incidence was recorded in control. Bavistin (0.25%) gave the highest number of umbels/plant, number of umbel lets/plant, number of seeds/umbel, number of seeds/plant, weight of seeds/plant and seed yield (586.5 kg/ha) which was followed by Provax and Sunvit, and the lowest of these parameters were obtained from control treatment.

Effect of fungicides in controlling Alternaria blight of cumin

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during 2014-15 to find out the effective fungicides in controlling Alternaria blight of cumin. Four fungicides viz. Rovral 50 WP @0.2%, Companion @0.2%, Secure 600 W @0.15%, Sunvit 50 WP @0.5% and one control were used as treatment. Cumin line CN 026 was used in this experiment. Three fungicides reduced disease significantly over control. Alternaria blight ranged from 14.40 - 90.81%, while the lowest severity was recorded in Rovral 50 WP (0.2%) sprayed plots and the highest severity was recorded in control treatment. Rovral 50 WP (0.2%) gave the highest number of umbels/plant, number of umbel lets/plant, number of seeds/umbel, number of seeds/plant, weight of seeds/plant and seed yield (675.0 kg/ha) which was followed by Companion and Secure 600 W. Sunvit and control treatment did not produce any seeds.

Management of gummy stem blight (black rot) on bottle gourd

The experiment was conducted at RARS, Rahmatpur, Barisal during 2014-2015. Management of gummy stem blight (black rot) 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+Trofloxystobin) @ 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 (Mancozeb + Metalexyl) @ 0.2% and *Trichoderma harzianm* 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%)/ Timseen (0.1%) effectively control the gummy stem blight (black rot) on bottle gourd.

Effect of fungicides in controlling late blight disease and yield of potato for late plantation

Five different fungicides Melody Duo @ 0.2%, Secure @ 0.1%, Acrobat MZ @ 0.2%, Ridomil @ 0.2% and Dithane M 45 @ 0.2%) and four combinations of fungicide Melody Duo @ 0.2% + Dithane M 45 @ 0.2%, Acrobat MZ @ 0.2% + Dithane M 45 @ 0.2%, Secure @ 0.1% + Dithane M 45 @ 0.2% and Ridomil @ 0.2% + Dithane M 45 @ 0.2% along with control were evaluated to assess the yield loss or gain for using fungicide starting from early growth stage of crop and to find out suitable fungicide(s) or combination of fungicides for effective management of late blight of potato for late plantation. Seeds of susceptible variety Diamant were planted on 15th December 2014. Significantly the highest yield (52.32 t/ha) and least disease severity (3.00%) was recorded at 70 days after planting in Acrobat MZ @ 0.2% + Dithane M 45 @ 0.2% sprayed plot. Acrobat MZ @ 0.2% was the best of all individual fungicides.

Effect of new fungicides in controlling late blight disease of potato

A field trial to evaluate the efficacy of some chemical fungicides for the control of potato late blight disease was done during the rabi season of 2014 – 2015 at Regional Agricultural Research Station, Burirhat, Rangpur. Fifteen (15) new chemical fungicides along with two recommended fungicides were evaluated at predetermined doses. Among the fungicides 12 were found highly 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 were within the range of 2.00% - 4.66%.

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 2014 – 2015 at Regional Agricultural Research Station, Burirhat, and 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 lower diseases were observed in the two resistant varieties than the susceptible variety. In case of yield, significantly highest yield was obtained from the resistant variety BARI Alu-46. Although the yield of other resistant variety (BARI Alu-53) was higher than the susceptible variety but it was statistically similar. In the interaction of variety and spray schedule it is observed that in case of susceptible variety the yield was significantly increased as the number of spray increased. But in case of resistant variety BARI Alu-46 although the highest yield was obtained from four sprays it was statistically similar to three sprays and two spray. In BARI Alu-53 the highest yield was obtained from four sprays which was statistically different from three sprays and two spray.

Eficacy of different chemical fungicides on Alternaria leaf spot of broccoli

An experiment was conducted during 2014-2015 cropping season to study the efficacy of eight fungicides and one botanical oil (mahogany oil) for controlling Alternaria leaf spot of Broccoli in the plant pathology field of RARS Jessore. Amister Top gave lowest disease index (1.27) and lowest number of diseased leaf. Simultaneously,this treatment increased plant height (46.33cm) with moderate plant weight (347gm) and performed the highest yield (3.77kg/plot) of broccoli compare to control.

Efficacy of different fungicides for controlling botrytis blight of gladiolus

The experiment was conducted at Panisara, Godkhali, and Jessore to study the effect of different fungicides for controlling Botrytis blight of Gladiolus. There were nine fungicides such as Deconil 500EC (1.5ml/L), Amister Top (1ml/L), Nativo 70 WP(.5gm/L), Iprozim 26 (2gm/L), Neem leaf extract (2ml/L), Ridomil Gold (1gm/L), Indofil M-45 (2gm/L), Antracol 70WP(4gm/L), Dithane M-45 (2gm/L) and control used as treatments. Among all the treatments the lowest disease scale (1.533), and disease severity% or PDI (66.66) was recorded from Antracol treated plots, whereas Deconil 500EC reduced the disease scale and disease severity moderately (2.133 and 72.22%) but performed better in all other vegetative and floral characteristics such as plant length (100.8cm), floret number(12.47) and flower length(43.47cm) etc.

Incidence of mango scab disease and its management

A field trial was conducted at the Regional Horticulture Research Station, Chapai Nawabganj during February to June, 2015 to find out the reaction of eleven most popular mango varieties against the disease and to find out the suitable fungicide to control the disease. Among the varieties the highest incidence (24.50% & 43.12%) and severity (4.90% & 13.15%) was recorded in Khirsapat. The lowest disease severity (3.53%) as well as the highest disease reduction (87.53%) was recorded from fruits treated with Iprozim 26 WP.

Efficacy of new fungicides in controlling anthracnose of mango fruits

A field trial was conducted at the Regional Horticulture Research Station, Bangladesh Agricultural Research Institute, Chapai Nawabganj in Bangladesh during February to July 2014, to test the efficacy of 27 new fungicides against post-harvest anthracnose of mango fruits. None of the fungicides under investigation was able to control the disease completely. Out of 27 fungicides Palki 75 WG (Tebuconazole + Trifloxobin), Fuji SC (Dificonazole + Azoxystrobin), Nativo 75 WG (Tebuconazole + Trifloxobin), Ecozole 10 EC (Hexaconazole) and Rodazim 50 WP (Carbendazim + Iprodazim) were the best fungicides to control postharvest anthracnose. Among the fungicides five fungicides i.e. Zole plus (Dificonazole + Propiconazole), G- force 5 EC (Hexaconazole), Durjoy 300 EC (Dificonazole + Propiconazole), Sinmaze 80 WP (Mancozeb) and Sunzoxy (Azoxystrobin + Tebuconazole) were not able to control more than 80 % of the disease. But rest of the fungicides was able to control more than 80 % of the disease.

Efficacy of new fungicide in controlling foot rot of betel vine

An experiment on efficacy of new fungicide in controlling foot rot of betel vine was conducted at the farmer field Mohonpur, Rajshahi during July-September 2014. Management of betel foot rot disease was tested with Amistar top 325 SC (0.5% and 0.1%) under field condition. Nativo 75 WG (0.2%), and Sulcox (0.5%), were used as standard check with one control.The lowest disease incidence (6.87%) and highest disease reduction (76.70%) over control was recorded from Amistar top @ 0.05%. In the result, it was found that Amistar top (0.05%) effectively control the foot rot (vine rot) disease of betelvine.

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. There were five different treatments namely: Thiovit, Copper Oxycloride, Imidacloprid, Cypermethrin with Propiconazole and Control (Water). All the tested pesticides reduced the disease over control. Out of five treatments, Admire and Cypermethrin with Propiconazole were effective against sooty mold of mango.

Post-harvest disease management of banana

Chitosan (CH) showed significant effect in controlling anthracnose (*Colletotrichum gleosporioides)* disease of banana. Application of Chitosan both at 1.5 and 2 % concentration reduced 50% disease incidence. The virulence of pathogen was declined with increasing concentration level of Chitosan. Lowest disease score was recorded 1.2 at CH 2% followed by CH 1.5% and CH 1% were 1.4 and 3, respectively. Both, total soluble solid (TSS) and weight loss (WL) were lowest 9.6 and 20.01% at CH 2% level, respectively.

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 chemical fungicide Provax were tested against soil-borne pathogens, *Sclerotium rolfsii* and *Fusarium oxysporum* of chickpea causing foot & root rot and wilts 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 lentil which was significantly differed from the other treatments including control. Seed treatment with chemical fungicide Provax showed better performance against the disease and also seed treatments with Trichoderma spores suspension and soil amendment with poultry refuse gave similar effect. 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 using poultry refuse and 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 Provax were the best treatments in reducing seedling mortality and increasing 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.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen S*clerotium 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 were effective 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 was at per the soil amendments with organic compost and vermin-compost in reducing seedling mortality and increasing plant growth and yield of lentil.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen *Sclerotium rolfsii* of groundnut

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 groundnut caused by *Sclerotium rolsfii*. The present study revealed that soil amendment with Tricho-vermi-compost and Tricho-organic-compost were effective in reducing seedling mortality and in increasing yield of groundnut. Seed treatment with chemical fungicide such as Provax showed better performance against the disease and its effect was at per with the soil amendments with vermin-compost and organic compost in reducing seedling mortality and increasing yield of groundnut.

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 in decreasing seedling mortality and enhancing plant growth and yield of barley.

Application of Biological Soil Disinfestation (BSD) for controlling wilt of tomato

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 1.97%. 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 (60.80 t/ha).

Study on the interaction effect of planting time and spray schedule with different fungicides on development of stemphylium blight of lentil

The experiment was conducted at the experimental field of Plant Pathology Division, RARS, Jessore to study on the interaction effect of planting time and spray schedule with different fungicides on development of Stemphylium blight of lentil in a split plot design. There were four main treatments such as sowing date 26th October, 5th November, 15th November and 25th November, four subplot treatments such as spraying at 40 DAS (Days after Sowing), 50 DAS, 60 DAS and 70 DAS. Among them the planting date 05 November 2014, and the spray schedule started after 50DAS showed better performance for increasing the yield contributing characters such as the highest no of pod/plant (97.67), the highest yield/plot (0.9417kg), with the highest 1000 seed weight (15.33 gm) than control.

Integrated management of foot rot (*Sclerotium rolfsii*) disease of groundnut

The experiment was conducted at Oil Seed Research Centre in the previously infected field by *Sclerotium rolfsii* at BARI during 2013-14 to test the efficacy of eight treatments combination like T_1= Soil treatment (Contaf 5 EC 0.1 %), T_2=Seed treatment (Provex 2.5 g / kg seed),T_3= Antagonist (Tricho compost 2.5 t/ha), T_4=.T_2 + T_1, T_5= T_1 + T_3, T_6=T_2+T_3 , T_7= T_1+ T_2+ T_3 and T_8= control. Soil treatments were used in furrow of the line and Trocho- compost were used within the two furrows before seed sowing and for T_4, T_5 and T_6 treatments, half amount were used in case of T_1 and T_3. In the field study, Contaf 5 EC and Provex decreased the maximum seed rot of ground nut seedlings and also gave the high germination of groundnut seed. On the other hand, the combination of soil treatment and soil treatments with Contaf 5 EC and Provex gave the maximum reduction of foot rot infection of groundnut seedling. Therefore, Contaf 5 EC and Provex gave considerable reduction of foot rot disease, in addition the yield increase of groundnut. Among the treatments use of Provex for seed treatment and Contaf 5EC for soil drencing gave satisfactory results to reduce the foot rot disease and increase the yield of groundnut.

Management of rhizome rot of ginger through chemicals and bio-control agents

The experiment was conducted in heavily infected sick plot with rhizome rot disease at Spices Research Centre, Shibganj, Bogra, Bangladesh during 2014-15 to find out suitable control measures of rhizome rot disease of ginger. Seven treatments including control were used in this experiment. The crop variety was BARI Ginger-1. The lowest infected plants (27.96%) at 95 DAP was recorded in T_2 (Soil drenching with Ridomil gold (0.3%), were first drenching was done during planting, there after, drenching was continued at 30 days interval starting from 45 DAP) The highest infected plants (44.88%) was obtained from untreated control at 95 DAP and After 95 DAP, the crop was gradually damaged by rhizome rot disease.

Integrated management of rhizome rot of ginger

The experiment was conducted in heavily infected sick plot with rhizome rot disease at Spices Research Centre, Shibganj, Bogra, Bangladesh during 2014-15 to find out the control measure of rhizome rot disease of ginger through an integrated management. Eight management practices including control were used in this experiment. The crop variety BARI Ginger-1 was used in this experiment. The lowest infected plants (24.75%) at 95 DAP was recorded in T_4 {Soil application with Stable bleaching powder during planting and 1st earhing up @20 kg/ha + Seed treatment and soil drenching during 1st and 2^{nd} earhing up with Ridomil gold (0.3%) + Trench surrounding the bed}. The highest infected plants (47.15 %) was obtained from untreated Control at 95 DAP. After 95 DAP, the crop was gradually damaged by rhizome rot.

Integrated management of betel vine diseases

The experiment was conducted at RARS, Rahmatpur, Barisal during 2014-2015 with 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 to control beld vina diseases. From this experiment, it was found that Provax-200 (0.2%)+ Ridomil Gold(0.2%) effectively control the leaf rot (*Phytophthora parasitica*), leaf spot (*Colletotrichum capsici*)and vine rot (*Sclerotium rolfsii*) disease of betel vine.

Integrated management of anthracnose disease of guava

Efficacy of different approaches namely Pruning, Fertilizer (NPK-100-100-100 g/plant), Fertilizer + Pruning, Fertilizer +Pruning + Single Spray of Knowin (0.1%), Fertilizer +Pruning + Double Spray of Knowin (0.1%), Fertilizer +Pruning + Triple Spray of Knowin (0.1%) and control were tested against anthracnose disease of guava under natural field condition. From the results, it was found that Pruning + Fertilizer + Triple Spray of Bavistin (0.1%) gave the best performance in controlling anthracnose disease of guava and increase yield.

Integrated management of stem rot (*Macrophomina phaseolina*) in sesame

The experiment was conducted at RARS, Rahmatpur, Barisal during 2013-2014. Management of stem rot diseases was conducted by seed treatment with Provax-200(0.2%) and spraying 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%) , Neoban (0.1%) , Neem leaf extract (1:1) and *Trichoderma harzanium* under natural condition .From this experiment, it was found that seed treatment with Provax-200(0.2%) and two sprays of

Bavistin (0.1%) + Dithane M-45(0.2%) after 30 DAS and 45 DAS effectively control the stem rot (*Macrophomina phaseolina*) disease of sesame.

Development of disease management package for lentil

The experiment was conducted at the experimental field of Plant Pathology Division, RARS, Jessore to develop a disease management package for lentil in a split-split plot design. There were four main treatments, two subplot treatments, three sub-subplot treatments with one control. Among the treatments Poultry litter x Provax x Rovral performed the highest 1000 seed weight (12.13 g), plot yield (0.82kg/6m^2), with moderate disease control.

Integrated management of post harvest Anthracnose and Stem-end rot of mango

A field trial was conducted at the Regional Horticulture Research Station, Chapai Nawabganj during May to June, 2015 to evaluate the effect of different treatments against post-harvest anthracnose and stem-end rot of mango fruits. Among the treatments significantly the highest disease reduction was observed in integrated approach with Bavistin DF and harvesting with one inch stalk compared others.

Survey and identification of diseases and isolation of pathogens of fennel

The experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during 2014-15 to identify and isolate the pathogens of different diseases of Fennel. Diseased plant samples having typical symptoms were collected from the different experimental fields of Spices Research Centre, Shibganj, Bogra for isolation of causal pathogens of different diseases of Fennel. Isolated and identified pathogen of umbel blight of Fennel was *Alternaria brassicicola*, which was purified by using PDA. Data on Fennel diseases were recorded from 10 Fennel lines. Among the Fennel lines, wilt incidence was very poor ranged from 0-5%. Alternaria leaf and umbel blight ranged from 11.00-31.33%, while the lowest leaf and umbel blight was obtained from Fennel line FN 09 which was statistically similar to FN 03 (11.67%) and FN 07 (14.00%), and the highest severity was obtained from FN 10 which was statistically identical to FN 06 (27.67%) and FN 02 (28.33%).

Survey of floral malformation of mango in major mango growing regions of Bangladesh

The study was conducted to assess the prevalence and severity of mango floral malformation during March to April 2015. Fifty locations were visited in five upozillas of Chapai Nawabganj districts with the objectives to confirm the status and update the existing statistics for the future planning and management. The disorder was found widely distributed. The average severity (6.65%) was observed in Gomostapur upozilla followed by Nachol (6.21%). All the traditional cultivars were more or less affected. Among the varieties the highest severity (15.53 %) was recorded from Ashwina followed by BARI Aam-3 (13.78%). Ashwina and BARI Aam-3are moderately susceptible (MS) while BARI Aam -1, Fazli and Mallica are moderately resistant and others are tolerant variety to the malady.

Survey and identification of causal pathogen of black spot of litchi at Rajshahi region

A survey was conducted in Rajshshi region including Ishurdi (Pabna) during 2014-15 to identify the diseases of litchi. After isolation, identification and pathogenicity test it was confirmed that causal agent of black spot/brown spot of litchi was *Colletotrichum* sp. Highest percent diseases incidence was found in early variety BARI litchi 1 compare to bombai and average diseases incidence was found 7.35%.

Nematode Disease Management

Yield loss assessment of onion due to root-knot nematode *Meloidogyne incognita* infestation

Root-knot nematode, *Meloidogyne* spp. infected commercially grown all onion cultivars in Bangladesh, its yield loss was established in the present study. The effects of different pre-plant population levels of *Meloidogyne incognita* on onion in pots were evaluated. Onion yield decreased as the nematode population increased with the few exception. Bulb weight was reduced by 03.43 to 27.58% when plants were inoculated with 2 to 10 g/kg soil of root knot nematode (*M. incognita* infested chopped gall roots of tomato). The pre-plant inoculums density 8 g/kg soil showed more reduction by 27.58% of bulb yield.

Efficacy of organic soil amendments and a nematicide for management of root-knot nematode *Meloidogyne* spp. of onion

A field experiment was conducted to evaluate the organic materials and a nematicide for management of root knot nematode of onion. Root knot nematode (*Meloidogyne* spp.) infested field soils were treated with Furadan 5G, poultry refuse, mustard oilcake, saw dust, rice bran and Tricho-composts. All the treatments gave satisfactory reduction of gall development on roots and increased plant growth as well as yield of onion. Among the treatments, poultry refuse and Tricho-composts appeared to be the best amendments for root knot nematode reduction and improvement of plant growth as well as increased yield of onion. Mustard oilcake was also proved to be better amendment for reduction of root knot nematode which enhanced plant growth and increased yield of onion.

Screening of neem products against root-knot nematode, *Meloidogyne incognita* of tomato

Both pot and field experiments were conducted to evaluate the neem based products such as neem leaf powder, neem leaf extract, neem seed extract, neem oil and neem oil cake for management of root knot nematode (*Meloidogyne incognita*) of tomato. Root knot nematode infested field soils were treated with those neem based product as well as chemical nematicide Furadan 5G. All the treatments gave appreciable reduction of gall development on roots and increased plant 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 increasing plant growth as well as yield of tomato.

Bacterial diseases management

An *in-vitro* study on antagonism of Rhizosphere bacteria against foot rot causing pathogen, *Sclerotium rolfsii* of lentil

An experiment was carried out in plant pathology laboratory, BARI to get some antagonistic bacterial isolate against foot rot disease causing pathogen, *Sclerotium rolfsii* of lentil. A total of 98 bacteria were isolated through soil dilution on King's B (KB) medium, seven showed antagonism and developed up to 0-30 mm inhibition zone.

Screening of tomato germplasm resistant to bacterial wilt

Twenty seven tomato accessions were screened to find out bacterial wilt resistance source grown under artificial epiphytotic field conditions during 2014-2015 cropping seasons. BARI Tomato 2 and 6 gave resistant reaction upto 6.66% mortality under Gazipur conditions. Twenty one accessions of tomato were showed moderately resistant reaction to *R. solanacearum* which were subjected to further evaluation for confirmation.

Collection, isolation and preservation of bacterial wilt pathogen from different host

Nine samples were collected from surveyed area, 3 from brinjal, 4 from tomato and 2 from ginger. The pathogen was isolated on specific medium and pure bacterial colonies were preserved as type culture.

Virus diseases management

Effect of planting dates on *cucumber mosaic virus* in chilli (C*apsicum annum* L.)

An experiment was conducted to find out the effective planting date to minimize the incidence of Cucumber mosaic virus (CMV) and study the relationship between disease incidence and vector population on chilli (*Capsicum annum* L.). BARI Marich-1 was planted at the research field of Plant Pathology Division, BARI Gazipur on six different dates viz. 1st November, 15th November, 30th November, 15th December, 30th December and 15th January of 2014-15 with four replications. Four yellow traps were placed in the experimental field after transplanting to attract the aphid for vectors counting. Significant variation of disease incidence and severity was found in different planting dates. Disease incidence and severity ranged from 19.75 to 47.25 % and 0.83 to 3.29 respectively in different planting dates. The lowest disease incidence and severity was found on 30th November planting. The highest disease incidence and severity was recorded from 15th January planting. There was significant positive correlation between aphid population and incidence of CMV in the field.

Screening of pumpkin genotypes against *Cucumber Mosaic Virus* (CMV) through artificial inoculation

The experiment was conducted in net house of Plant Pathology Division, BARI Gazipur to find out CMV resistant/tolerant pumpkin genotype or line through artificial inoculation. Forty gerplasm were collected from PGRC, BARI and evaluated against CMV. Among the germplasm eleven accessions (BD4357, BD4359, BD4360, BD4364, BD4370, BD4378, BD4382, BD4391, BD9872, BD9877 and BD10297) were found highly susceptible, fifteen accessions (BD4349, BD4350, BD4353, BD4354, BD4368, BD4372, BD4381, BD4383, BD4395, BD9871, BD9875, BD9879, BD9880, BD10295 and BD10295) were recorded as susceptible, six accessions (BD4348, BD4358, BD4371, BD4380, BD4393, BD4397 and BD9889) were graded as moderately susceptible, four accessions (BD4351, BD4352, BD4363 and BD9870) were graded as moderately resistant and three accessions (BD4355, BD4361 and BD10303 were found to be resistant against CMV under artificial inoculation.

Management of virus diseases of watermelon through intercropping with different crops

The experiment was conducted at RARS, Rahmatpur, Barisal during 2014-2015. Management of virus diseases of watermelon was conducted by intercropping with different crops viz. Wheat, Maize, Millet, Sorghum and sole. From this experiment, it was found that intercropping with millet and wheat effectively controls the virus diseases of watermelon as well as increase the yield.

18 PLANT PHYSIOLOGY

Variability in growth and development of potato varieties at different regions of Bangladesh

The experiment was carried out at the research field of Plant physiology Division, BARI, Joydebpur, Gazipur and Wheat Research Centre, Nashipur, Dinajpur during *rabi* season of 2014-15 to evaluate the growing degree days (GDD) for different developmental stages and also to determine the growth and yield of potato varieties in both the locations. The treatments included four potato varieties viz, BARI Alu 7, BARI Alu 8, BARI Alu 13 and BARI Alu 25. Among the varieties, BARI Alu 25 took maximum GDD and growth duration compared to other varieties and BARI Alu 13 had needed minimum GDD as well as shorter growth duration irrespective of location. BARI Alu 7 showed the highest leaf area index (LAI) followed by BARI Alu 8 and BARI Alu 25 and the lowest LAI was found in BARI Alu 13 in both the locations. In all the varieties, changing pattern of specific leaf weight (SLW) was similar and it was found higher at Gazipur location compared to Dinajpur. On the contrary, potato grown at Dinajpur had better specific leaf area (SLA) than that of Gazipur. Among the varieties, BARI Alu 7 showed the higher total dry matter (TDM) throughout the growing period followed by BARI Alu 8 regardless of locations and the lowest TDM observed in BARI Alu 13. In both the locations, 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. The highest tuber yield was obtained from BARI Alu 8 (29.8 t/ha) which was identical with that of BARI Alu 7 (28.1 t/ha) at Dinajpur location and BARI Alu 13 produced the lowest tuber yield (15.6 t/ha) at Gazipur location. In case of total N uptake, BARI Alu 7 took maximum N (137.4 kg/ha) followed by BARI Alu 8 (135.5 kg/ha) at Dinajpur location. Between two locations, Dinajpur is suitable for potato production due to its sandy loam soil texture and prevailing lower temperature which is favourable for tuber growth.

Assessment of drought tolerance in wheat genotypes by osmotic stress imposed at early seedling growth stages

The experiment was conducted in the laboratory of Plant Physiology Division, BARI, Gazipur during October to December 2014. Sixty four genotypes and three osmotic stress levels viz. control (without PEG), 15% and 25% PEG solution were used in this experiment. Among the genotypes, mean germination percentage of 92, 78, 51% and shoot dry weight per seedling of 10.0, 7.8 and 5.1 mg were found in control, 15% PEG and 25% PEG treatment, respectively. Average root dry weight was found identical in both control and 15% PEG treatment, but decreased at 25% PEG treatment. Amount of respiration was found lower in PEG treated seedlings though a higher value of seed metabolic efficiency was observed in both 15% and 25% PEG treatment. Compared to control treatment, more seed dry matter remained in seed under PEG treatment resulting in lower seedling growth. A significant positive correlation exists between the important growth parameters like germination (%), shoot dry weight, root dry weight and amount of respiration with vigour index. On the basis of these physiological traits sixteen genotypes such as BD-553, BD-557, BD-558, BD-559, BD-571, BD-575, BD-578, BD-580, BD-585, BD-586, BD-587, BD-588, BD-591, BD-594, BD-595 and BD-597were selected as drought tolerant for further evaluation.

Developmental stages, growth indices and yield of hybrid maize cultivars as affected by growing seasons

The experiment was conducted to evaluate the developmental stages, growth and yield performance of hybrid maize varieties during *rabi* season of 2014 -2015 at the research field of Plant Physiology Division, BARI, Joydebpur. Four maize varieties namely BARI Hybrid Maize 7, BARI Maize -9, Pioneer and NK-40 were used. Seeds were sown on November 18, 2014 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, murate of potash and gypsum. Irrigation was given as and when required to maintain adequate soil moisture. Canopy light interception was measured at different growth stages and plants were sampled for leaf area and dry matter measurement. Ten plants from each plot were tagged at two-leaf stage which was used for destructive sampling to determine tassel initiation/end of juvenile stage. Three plants of each variety were removed at regular intervals (every 2-3 days) starting from 12 days after emergence. The apex was dissected under a stereoscopic microscope and observed carefully. When the tip of tassel was visible under microscope data was recorded. Maize was harvested at physiological maturity (BHM-7 & BHM-9 at 145 days after sowing (DAS); NK-40 at 146 DAS and Pioneer at 147 DAS) and yield data was taken from the whole plot. The yield components data were collected from 5 randomly selected plants prior to harvest from each plot. From *rabi* season experiment, it was found that there exist some differences in phenological development and physiological maturity of the varieties. BARI Hybrid Maize 7and BARI Hybrid Maize 9 finished juvenile stage at 26 DAS with 295 growing degree days (GDD), while Pioneer at 28 DAS with 316 GDD and NK-40 at 27 DAS with 305 GDD. The varieties attained at physiological maturity within 145-147days after sowing with GDD of 1686 to 1731. However, remarkable variations were observed in leaf area index (LAI), canopy light interception, radiation use efficiency (RUE), dry matter production and yield of maize varieties. Higher LAI, canopy light interception, RUE and dry matter production was found in BARI Hybrid Maize 9 throughout the growing period followed by Pioneer, NK-40 and BARI Hybrid maize 7 which was reflected in their grain yield. The highest total dry matter (TDM) was observed in BARI Hybrid Maize 9 at harvest followed by BARI Hybrid maize 7, NK-40 and Pioneer. But in dry matter partitioning aspect, NK-40 was more efficient than others which allocated 69% of its TDM to cob followed by Pioneer (64%), BARI Hybrid maize 7(63%) and BARI Hybrid Maize 9 (62%). However, grain yield of the varieties were identical, which ranged from 10.16 t/ha (BARI Hybrid maize 7) to 10.94 t/ha (Pioneer).

Growth analysis of selected maize genotypes under variable soil moisture regimes

The experiment was conducted at the research field of Plant Physiology Division of BARI, Joydebpur, Gazipur during *rabi* season of 2014-15 to find out suitable maize genotypes for drought environment. Selected six maize genotypes, $V_1 = P_1$ x P_4, $V_2 = P_1$ x P_7, $V_3 = P_2$ x P_6, $V_4 = Q_8$ x Q_6, V_5 = BARI Hybrid Maize 5 and V_6 = Suvrah were tested under well watered and drought condition (irrigate with wilting symptom visible + one irrigation at tasseling stage treatments). Seeds were sown on November 20, 2014. Fertilizers were applied at the rate of 250-55-100-30 kg/ha N, P, K and S as urea, triple super phosphate. muriate of potash and gypsum. Irrigation was given as and when required to maintain optimum soil moisture in well watered plot while only one time irrigation was given in drought plot. Leaf greenness (SPAD)was measured at different growth stages. Leaf stomatal conductance was measured at tassel emergence stage (90 DAS) where fully expanded third leaf from top was used for measurement. Plants were sampled at different growth stages for leaf area and dry matter content. At pre tasseling stage (82 DAS) leaf samples (3rd leaf from top) were collected and bio-chemical analysis was done in laboratory for catalase (CAT) and ascorbate peroxidase (APX) content of leaf. At harvest, yield components data were collected from 5 randomly selected plants and yield data was taken plot wise. Drought reduced leaf chlorophyll content (SPAD value), leaf area index (LAI), total dry matter production (TDM) and ultimately reduced grain yield. However, genotypes varied in the reduction of growth parameters and yield due to drought stress. Among the genotypes, V_1, V_4 and V_3 showed higher LAI, TDM and grain yield (8.73, 8.51 and 8.03 t/ha, respectively) compared to others. But genotypes V_6 and V_5 produced the lowest grain yield (7.07 t/ha and 7.29 t/ha). Drought affected enzymes activity of the genotypes. It increased activity of CAT and APX in maize genotypes. These enzymic antioxidants are used to reduce the damaging effect of reactive oxigen species (ROS) in plant cell under drought stress. Among the maize genotypes, V_1, V_4 and V_3 showed higher CAT and APX activity under drought than others indicating that these genotypes are more capable to withstand in drought situation compared to others. Besides, these genotypes showed higher stress tolerance index (STI) and Geomatric Mean Productivity (GMP) compared to others. Results revealed that genotypes V_1, V_4 and V_3 would be suitable for growing under soil moisture scarce environment.

Screening of maize genotypes against drought

A field experiment on identification of maize genotypes against drought stress was conducted during *rabi* season of 2014-15 at the field of Plant Physiology Division, BARI, Joydebpur, Gazipur. Two sets of maize genotypes (Set-I, 24 genotypes, Set-II, 25 genotypes) were evaluated under irrigated and drought (irrigate with wilting symptom visible + one irrigation at tasseling stage) conditions. The trial was non-replicated. Each genotype was grown in 2m long in 2-line (60 cm x 20 cm i.e 16 plants). Seeds were sown on November 23, 2014. Fertilizers were applied at the rate of 250-55-100-30 kg/ha N, P, K and S as urea, triple super phosphate, muriate of potash and gypsum. Irrigation was done as and when necessary to maintain optimum soil moisture in well watered plot while only one time irrigation was given in the other treatment. Maize was harvested on April 20, 2015 (148 DAS). At harvest, the yield components and yield data were collected from 10 randomly selected plants. Among 24 genotypes, on the basis of yield, stress tolerance index (STI) and geometric mean productivity (GMP) genotypes Pac-60/S_4-14 × BIL-113, Pac-60/S_4-3 × CML-425, 900-M, BHM-9, Pac-60/S_4-8 × BIL-114, Pac-60/S_4-18 × BIL-113, Pac-60/S_4-21 × Utn/S_4-10, and Pac-60/S_4-5 × CML-425 could be selected as less sensitive to drought. On the other hand, among 25 genotypes (Set-II), genotypes 9MS/S_6-10 × BIL-114, 9MS/S_6-2 × BIL-114, 9MS/S_6-9 × BIL-114, 9MS/S_6-9 × 9MG/S_4-13, 9MS/S_6-13 × BIL-114, 9MS/S_6-12 × BIL-114, 9MS/S_6-1 × BIL-114and 9MS/S_6-18 × BIL-114 can be chosen as desired genotypes for growing under drought stress.

Evaluation of growth and yield of chickpea genotypes for rain fed condition

An experiment was carried out at the field of Plant Physiology Division, BARI, Joydebpur, Gazipur during *rabi* season of 2014-2015 to find out suitable chickpea genotypes for rainfed condition. Fifteen genotypes viz. BD-6300, BD-6301, BD-6302, BD-6309, BD-6312, BD-6744, BD-6745, BD-6772, BD-6773, BD-6774, BD-6775, BD-6776, BD-6778, BD-6757, BARI Chola 5 and BARI Chola 9 were evaluated under rain fed condition. The crop was fertilized with 33-24-45-21-2-1 kg/ha NPKSZnB in the form of Urea, Triple super phosphate, Murate of potash, Gypsum, Zinc sulphate and Boric acid.

Seeds of each genotype were sown on 17 November, 2014 with 40 cm x 10 cm spacing at 1cm depth of soil. Pre-sowing irrigation was applied for ensuring seed germination and then the crop was grown under rain fed conditions. Intercultural operations and plant protection measures were done when necessary. BARI Chola 9, BD-6775, BD-6745, BD-6772 and BD-6309 were found better on the basis of leaf area, chlorophyll content, dry matter accumulation, yield and yield attributes under rain fed conditions.

Performance of selected wheat genotypes under salinity in pot culture

A pot experiment was conducted in vinyl house of Plant Physiology Division, BARI, Joydebpur, Gazipur during *rabi* season of 2014-2015. Four previously selected wheat genotypes viz. BAW-1135, BAW-1157, BARI Gom 25 and BAW-1151 (BARI Gom 29) were screened against salt tolerance under 0, 8 and 12 dS/m of Nacl solution. Earthen pots were filled with soil and cow dung in 4:1 volume ratio. Fertilizers were applied at the rate of 120-30-90-15-6-2-1 kg/ha NPKSMgZnB. Ten seeds of each genotype were sown in each pot on 20 November 2014. 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 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 affected greatly by salinity level in respect of SPAD value, leaf area, leaf dry weight, root volume, root and shoot dry weight, days to heading and flowering, plant height and number of effective tillers 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 those regards. Considering above growth parameters, BAW-1135 and BARI Gom 29 were selected as tolerant up to 12 dS/m salinity level.

Salinity stress on physiological changes, dry matter production and yield of selected mustard genotypes at variable growth stage

A pot experiment was carried out in vinyl house of Plant Physiology Division, BARI, Joydebpur, Gazipur during *rabi* season of 2014-2015 to study the effect of salinity stress on mustard genotypes at variable growth stages. The treatments included two genotypes viz. BARI Sarisha 14 and BD 9093 and two growth stages viz., vegetative stage and reproductive stage. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to prepare 10.0 dS m^{-1} solution. Application of fertilizers and insecticides and weeding operation were done as and when required. In each pot, 10 seeds were sown on 15 November 2014. NaCl solution application inhibited the growth of mustard plant and caused to decrease both shoot and root dry weight. The addition of NaCl in the soil increased total chlorophyll content in plants. Sodium concentration in root, pod and stem of both genotypes significantly increased at variable growth stages. On the contrary, K Concentration in root, pod and stem of both genotypes significantly decreased at variable growth stages. Among the two genotypes, BARI Sarisha 14 performed better in case of yield contributing characters and yield under salinity imposed at variable growth stages.

Screening of wheat genotypes against salinity stress under laboratory condition

Forty wheat genotypes were tested against varying levels of salinity (0, 5, 10 and 15 dS m^{-1}) in Hoagland solution under laboratory condition of Plant physiology Division, BARI, Gazipur during *rabi* season of 2014-2015 to find out salt tolerant genotype(s) at seedling stage. Distilled water (0 dS m^{-1}) was used as a control. Germination percent, seedling root and shoot length, root and shoot dry weight and Vigor index were affected by different levels of salinity. The genotypes, BAW-1214, BAW-1220, BAW-1222, BAW-1223, BAW-1195, E-9,E-67, E-19, E-40 and E-50 showed better performance upto 15 dS m^{-1} based on relative germination percentage, relative root and shoot dry weight, relative root and shoot length and vigour index reduction over control. These genotypes could be selected for further investigation under pot culture.

Screening of grass pea genotypes against salinity

The experiment was conducted at the Laboratory of Plant Physiology Division, BARI during 2013-2014 to select the salt tolerant grass pea genotypes at germination and seedling stages. Twenty grass pea genotypes (IF-463, IF-587, IF-1304, IF-1327, IF-1332, IF-1351, IF-1872, IF-1942, IF-2096, IF-2156, SEL-13222, SEL-1330, SEL-1335, SEL-1336, SEL-1345, SEL-1348, IF-1344, IF-2329, BKX-00024 and BKX-000111) were tested against varying levels of salinity viz. 0, 4 8 and 12dS/m in Hoagland solution. Distilled water (0 dS/m) was used as control. Germination percentage (GP), root length (RL), shoot length (SL), vigor index and total dry matter (TDM) were found to be affected by salinity. The genotypes IF-463 and IF-2329 showed better performance up to 12dS/m and survived up to 15 days after germination. The result revealed that genotypes IF-463 and IF-2329 might be tolerant upto 15 days after germination in 12 dS/m NaCl solution under laboratory condition.

Effect of top cutting on yield and seed quality of groundnut (observation trial)

An experiment was carried out at the field of Plant Physiology Division, BARI, Joydebpur, Gazipur during the period from November, 2014 to May, 2015 to find out the optimum time of top cutting for early maturity of groundnut varieties in char land areas. The experiment comprised of two groundnut varieties V_1 = BARI chenabadam 8 and V_2 = Dhaka 1 (Local) and five top cutting time: C_1= Top cutting at 100 days after sowing, C_2= Top cutting at 110 days after sowing, C_3= Top cutting at 120 days after sowing, C_4= Top cutting at 130 days after sowing C_5=No top cutting (Control) as treatment. Seeds were sown on 13 November 2014 with the spacing of 30cm × 15 cm spacing and harvested on 04 May 2015. The fertilizers were applied @ 30-24-40-24-1.0-0.7 and 0.2 kg ha^{-1} NPKSZnB and Mo, respectively (FRG, 2012). The results revealed that nut yield of groundnut due to the top cutting at earlier stages did not give any yield advantage compared to the control treatment. On the other hand, the nut yield was greatly reduced compare to the control treatment when the top cutting was done at later stages. So there was no positive relation with top cutting of groundnut with yield.

Study on growth and development of sweet corn at different water regime

The investigation was carried out at the Research field of Plant Physiology Division, BARI, Joydebpur, Gazipur during *rabi* season of 2014-15 to study the effect of irrigation at different growth stages on growth and development of sweet corn. The treatment included: T_1 = Well watered (Irrigation at 4, 6, 8 leaf stage, silking and tasseling stage), 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 after emergence. Seeds of sweet corn (cv. BARI Sweet corn 1) were sown on 23 November 2014. A light irrigation was given in all the plots to ensure proper emergence. Fertilizers were applied at the rate of 150-60-90-200 kg/ha NPK and S as urea, triple super phosphate, murate of potash and gypsum. Irrigation was given as per treatment. Soil moisture content of the experimental plots was monitored (60 cm depth) throughout the growing season. When the silks of cob turned to brown, the total soluble solid TSS (%) in juice was measured. The green cobs were harvested according to the treatments. Among the treatments, T_1 and T_3 showed higher LAI, TSS, total sugar and green cob yield (12.96 t/ha and 11.10 t/ha, respectively) compared to others. The results revealed that irrigation at 4 leaf stage and tasseling stage (T_3) would be economically suitable for sweet corn cultivation. Sweet corn cob should be harvested at 22 days after silking for maximum sweetness.

Influence of harvesting time on carbohydrate accumulation in some potato varieties

The experiment was conducted at the research field of Plant Physiology Division, BARI, Joydebpur during *rabi* 2014-15 to find out suitable harvesting time for accumulation of acceptable amount of carbohydrate in BARI Alu 25, BARI Alu 34 and BARI Alu 35. The experiment was laid out in RCB design. Tubres were sown on 20 November 2014. At emergence, a light irrigation was given in all the plots to ensure proper emergence. Fertilizer were applied @ 45-10-45-5 kg/ha NPK and S in the form of Urea, Triple Supper Phosphate, Murate of potash, Gypsum, respectively along with cow dung (10 t ha^{-1}) Irrigation was done as and when necessary to maintain optimum soil moisture. Plants were sampled at 75, 80, 85, 90, 95 days after planting (DAP) for dry matter content and to measure reducing and total sugar. The results revealed that 90 DAP was optimum time for tuber harvesting because at that time acceptable amount of reducing sugar, total sugar and Vitamin-C were observed. Three varieties under evaluation contained acceptable range of reducing sugar (below 0.5 %) and total sugar required for processing purpose.

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Performance of mango (kanchamitha) germplasm at hilly region

An experiment was conducted for the evaluation of two mango (Kanchamitha) germplasm (MI-Kha 001, MIKha and 002) at the Hill Agricultural Research Station, Khagrachari during 2014-15. The germplasm MI-Kha 001 had the maximum (6.20 m) and MI-Kha 002 had the minimum (5.30m) plant height. The highest canopy spread 5.80 m at north-south and 5.70m at east-west was obtained in MIKha001. The full blooming period was first week of January, 2015. The tree habit was spreading to intermediate type. Fruit harvesting period was 20th and 18th May, 2015. The highest fruits per plant were obtained from MI-Kha 001 (294) and the lowest from MI-Kha 002 (197). The maximum fruit weight was recorded from MI-Kha 001 (257 g) and the minimum was recorded from MI-Kha 002 (146g). Total Soluble Solids (TSS) was noted the highest in MI-Kha 001 (10.0%) and the lowest in MI-Kha 002 (9.0%). Edible portion was found higher in MIKha 002 (73.28%) while lower was in MIKha001 (66.67%). Considering yield and quality MI-Kha 001 was found promising to grow mango for using unripe condition.

Performance of off-season mango germplasm

An experiment was conducted to evaluation the off-season mango germplasm (MI-Kha 001 and MI-Kha 002 at the Hill Agricultural Research Station, Khagrachari during 2014-15. The full blooming period was June, 14 and January, 15. The tree habit was spreading type. Fruit harvesting period was December,14 and May,15 respectively. The highest fruits per plant were obtained from MI-Kha 001 (35) during January, 15 and the lowest in June, 14 (6) from MI-Kha002. The Maximum individual fruit weight was recorded from MI-Kha 001 during June,14 (460 g) and the minimum was recorded in June,14 flowering (95g) from MI-Kha002. Total Soluble Solids (TSS) was noted the highest in MI-Kha 001 during June flowering (18.0%). Edible portion was found 66.61% in MI-Kha 001in June 14 flowering. The highest yield (18.48kg) was obtained from MI-Kha 001 during January flowering while the lowest yield (0.38kg) gave MI-Kha002 during June flowering.The overall growth condition of the two germplasm was found satisfactory. Considering yield and quality MI-Kha001 was found promising for off-season cultivation of mango at hilly region.

Performance of grape germplasm

An experiment was conducted to develop a suitable grape variety for commercial cultivation at hilly region at the Hill Agricultural Research Station, Khagrachari during the period from February to July, 2015. Two grape germplasm viiz. VVKha 001 and VVKha 002 were under trail. The full blooming period was February, 15 and harvesting was done in July, 15. The Maximum number of fruits per cluster (28) was recorded from VVKha 001 while the maximum number of clusters per plant (13) was obtained from VVKha 002. Individual fruit weight (3.60g) was found maximumin in VVKha 002 with highest seeds (2.4) per fruit. Total Soluble Solids (TSS) was noted the highest (18%) in VVKha 001. The highest yield per plant was obtained from VVKha 002 (1.17kg) and the lowest in VVKha001 (0.71kg). Considering yield, quality and sweetness VVKha 001 were found most promising for cultivation of grape at hilly region. However, the experiment will be continued for final recommendation.

In-situ evaluation of year round pummelo germplasm

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2014-15. An off-season pummelogermplasm (CGKha001) 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. The 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 CGKha001. 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 taste. Therefore, CGKha 001 was found promising for year round cultivation of pummelo at hilly region.

Effect of liming (limestone) on yield performance of maize in the valley land of the chittagong hill tracts

The study was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari during the period from November 2014 to February 2015 to evaluate the effect of liming on the hybrid maize production in the hill valley of the Chittagong Hill Tracts. Four doses of limestone (0.0, 1.0, 1.5, and 2.0 t/ha) were tested. The maximum yield of green cob with husk (34.23 t/ha) and without husk (21.58 t/ha) were recorded in case of liming @ 1.5 t/ha in the field followed by 2.0 t/ha. In all the cases liming produced more yield than the control. Besides the maximum fodder yield (99.8 t/ha) was also produced by 1.5 t/ha lime. Application of 1.5 t/ha lime produced 20.15% and 6.07% higher green cob and fodder yield respectively than the control. For the maize cultivation in the Chittagong Hill Tracts of Bangladesh 1.5 t/ha limestone application may be recommended for better cob and fodder production.Best dose of liming (limestone) for the maize crop of the hilly area of Bangladesh might be recommended as 1.5 t/ha.

Effect of liming (dolomite) on yield performance of maize in the valley land of the chittagong hill tracts

The study was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari during the period from November 2014 to February 2015 to evaluate the effect of liming on the hybrid maize production in the hill valley of the Chittagong Hill Tracts. Four doses of dolomite (0.0, 1.0, 1.5, and 2.0 t/ha) were tested.Application of 1.0 t/ha lime (dolomite) for BARI Hybrid Maize-9 was given the maximum results in case of all parameters except plant height and days to 50% flowering. The maximum yield of green cob with husk (39.53 t/ha) and without husk (25.89 t/ha) were recorded in case of liming @ 1.0 t/ha followed by 1.5 t/ha. In all the cases each dose of lime was given to the maize field produced more yield than the control. For the maize cultivation in the Chittagong Hill Tracts of Bangladesh 1.0 t/ha dolomite application may be recommended for better cob and fodder production.Best dose of liming (dolomite) for the maize crop of the hilly area of Bangladesh might be recommended as 1.0 t/ha.

Screening of landrace maize at khagrachari hilly region of Bangladesh

The study was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari during the period from May 2014 to February to August, 2014 to evaluate the performance of land race maize production in the hill slope of Khagrachari hilly area of the Chittagong

Hill Tracts. The maximum plant height among the genotypes was recorded in ZMKha 1(212cm) and lowest plant height (127.11cm).The minimum ear height was found in ZMKha 10(66.6 cm) and highest ear height was recorded in ZMKha 1(195 cm). The minimum days to 50% silking was found in Shubra (63.80 days) and Bornali (65.2days) respectively. The highest no. of cob (2.2) was found in ZMkha 8 lowest (1.33) were found in Bornali. The maximum cob length (17.27cm), 100seed weight (35.66 g), and cob yield (6.73 t/ha) were found in BARI released variety Shubra and in all the same parameters very closed results were recorded in BARI released variety named Bornali. BARI maize Shubra and Bornali may cultivated in rain fed jhum field in Khagrachari hilly area of Bangladesh. BARI maize Shubra and Bornali may cultivated in rain fed jhum field in Khagrachari hilly area of Bangladesh.

Performance of mustard varieties in the hilly valley areas of Khagrachari

The study was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari during the period from November 2014 to February 2015 to evaluate the performance of mustard varieties in the hill valley areas. Five varieties of mustard (Tori-7, BARI Sarisha-14, BARI Sarasha-15, BARI Sarisha-16 and BJDH01) were tested. Among the varieties BJDH01 showed the maximum plant height and took maximum days for maturity. The same variety also gave the highest number of siliqua plant-1, and the highest yield. So, BJDH01 may be recommended for cultivation in the hill valley areas of Bangladesh. On the basis of growth duration, physi morphological growth parameters, yield components and yield, it might be concluded that BJDH01 may be recommended for cultivation in the hill valley areas of Bangladesh.

Effect of fertilizer package on yield and yield contributing characters of two maize varieties in hilly area

An experiment was conducted at HARS, Khagrachari during Rabi during 2014-15 to find out suitable fertilizer packages of maize in hilly area. Four fertilizer packages viz. T_1 : CD = 5 t/ha, N_0, P_0, K_0, S_0, Zn_0, B_0 T_2 : CD= 5t/ha, N_{150}, P_{30}, K_{75}, S_{20}, Zn_2, $B_{0.5}$ T_3 : CD= 5t/ha, N_{200}, P_{60}, K_{100}, S_{40}, Zn_3, B_1 (FRG 2012) T_4 : CD= 5t/ha, N_{250}, P_{90}, K_{125}, S_{60}, Zn_4, $B_{1.5}$ & 2 varieties(BARI hybrid Maize -7, BARI hybrid Maize-9)were used in this experiment. Among the fertilizer packagesT_4 was recorded higher in case of on Plant height (cm),Plant population/m2, No. of leaves during green con harvest , Number of cob/plant, Individual cob wt. with husk, Individual cob wt. without husk, Cob height (cm),Green cob yield (t/ha), Fodder yield. In case of interaction V_1T_4 (BARI hybrid Maize -7 +100% higher fertilizer than recommended) gives highest & statistically similar result with V_2T_4(BARI hybrid Maize -7 +100% higher fertilizer than recommended).Among the fertilizer packages T_4 : CD= 5t/ha, N_{250}, P_{90}, K_{125}, S_{60}, Zn_4, $B_{1.5}$ gives best result .Incase of interaction V_1T_4(BARI hybrid Maize -7 +100% higher fertilizer than recommended) gives highest & statistically similar result with V_2T_4(BARI hybrid Maize -7 +100% higher fertilizer than recommended). For recommendation this experiment should be continued for next year.

Effect of fertilizer packages on yield and yield contributing characters of onion in hill valley

An experiment was conducted at HARS, Khagrachari during Rabi during 2014-15 to find out suitable fertilizer packages of onion in hilly area. Four fertilizer packages viz. T_1 : CD = 5 t/ha, N_{60}, P_{12}, K_{40}, S_{10}, T_2 : CD= 5t/ha, N_{120}, P_{24}, K_{80}, S_{20},. (FRG 2012) T_3 : CD= 5t/ha, N_{240}, P_{48}, K_{160}, S_{40},T_4 : CD= 0t/ha, N_0, P_0, K_0, S_0, were used in this experiment. T_3 was recorded higher in case of plant height, plant population/m^2 but length of bulb, diameter of bulb, individual weight (g) and yield (t/ha) were highest in T_2. Statistically significant result was obtained from this experiment & the result revealed that recommended fertilizer dose for plain land T_2 : CD= 5t/ha, N_{120}, P_{24}, K_{80}, S_{20},. (FRG 2012) was also gives best result in hilly soil & may be economically profitable for the hilly farmers.For precise result this experiment should be continued for next year.

Evaluation of polyembryonic mango germplasm

An experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari to find out the performance of fifteengermplasm of poly-embryonic mango during 2015. The highest yield (62.12 kg/ plant) was recorded from MIRAM006 followed by BARI Aam 8 (50.84 kg/plant).

Evaluation of custard apple germplasm in hilly region

Ten custard apple germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The line AS RAM 005 produced the maximum number of fruits (41/plant) with heavier fruit (219.2 g/fruit). The maximum fruit yield (8.97 kg/plant) was obtained from the line ASRAM 005 and the maximum TSS (19.41%) was recorded in AS RAM 003 closely followed by ASRAM 005 (18.67%). There was a lot of variability in respect to fruit size, single fruit weight and TSS (%). The line AS RAM 005 produced the maximum number of fruits (41/plant) followed by AS RAM 006 (29/plant) and heavier fruit (219.20 g/fruit) produced by the line AS RAM 005. The maximum fruit yield (8.97 kg/plant) recorded from the line AS RAM 005 which was fur different with all others lines. Maximum TSS (19.41 %) was obtained from AS RAM 003 followed by ASRAM 005 (18.67%). Considering yield and quality ASRAM 005 was superior.Based on yield and quality it might be concluded that the custard line AS RAM 005 was superior.

Evaluation of indian dillenia germplasm in hilly region

Five Indian dilleniagermplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The line DI RAM 003 produced the maximum number of fruits (599/plant) while heavier fruit (518.2 g/fruit) was produced by the line DI RAM 005. The maximum fruit yield (263.6 kg/plant) was obtained from the line DI RAM 005 and the lowest yield (52.248kg/plant) was recorded in DI RAM 004. There was a lot of variability in respect to plant height, number of branch, spread of plant, fruit size, single fruit weight and edible portion (%). The highest plant height (24.25 m) was recorded from DI RAM 005 but maximum base girth (205 cm) was found from DI RAM 003 and maximum number of main branches (4/plant) also in DI RAM 003. The line DI RAM 003 has the highest canopy with E-W spread and N-S spread. The line DI RAM 003 produced the maximum number of fruits (599/plant) followed by DI RAM 005 (509/plant) and heavier fruit (518.26 g/fruit) produced by the line DI RAM 005. The maximum fruit yield (263.68 kg/plant) recorded from the line DI RAM 005 followed by DI RAM 003 (208.45 kg). Considering yield and yield contributing characters the lines DIRAM 005, and DI RAM 003 were superior.

Evaluation of rose apple germplasm in hilly region

Five lines of rose apple such as SJRAM 001, SJRAM 002, SJRAM 003, SJRAM 004, SJ RAM 005 were evaluated at the Hill Tracts Agricultural Research Station, Ramgah, Khagrachari during the year 2015 The line SJ RAM 005 produced the maximum number of fruits (933/plant) while heavier fruits (15.8g/fruit) produced by the line SJ RAM 003. The maximum fruit yield (13.92 kg/plant) was obtained from the line SJ RAM 001 and it was the lowest from SJ RAM 003 (9.21 kg/plant). The maximum TSS (13.44%) was also recorded from the line SJ RAM 001 having sweet taste and it was the lowest in SJ RAM 005 (10.23%). Considering yield and yield contributing characters the line SJRAM001 was better.

Performance of tisa germplasm in the hilly region

Five germplasm of Tisa fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2014. The maximum number of fruits (167), weight of fruits (20.15 kg) was obtained from the germplasm PC RAM 003 and TSS was also recorded highest (22.5%) in PCRAM 003 followed by PCRAM 005 (22.4%).

The result indicates that the line PCRAM 003 showed better performance. The line is under process to release variety.

Adaptive trials with BARI hybrid maize varieties in Khagrachari hill district

The experiment was carried out at the farmer's field of Ramgarh char, Matirangaupazilla and on station (Hill Tracts Agricultural Research station) under Khagrachari hill district during Rabi season of 2014-15 to evaluate the field performance of BARI hybrid maize varieties and to popularize BARI hybrid to farmer's field under charland and hill valley condition. BHM 5, BHM 7, BHM 9 and AS-999 were tested at different locations. Results indicated that BHM 9 performed better, highly competitive to commercial hybrid and produced the highest grain yield (7.98 t/ha) among the varieties. This variety also gave the highest returns (Gross return: Tk= 1,29,340/ha) and gross margin (Tk= 42,190/ha).BARI hybrid maize 9 was more profitable than all other maize hybrid.Farmer's reactions were positive for BHM 9 due to its higher yield. Seed germination rate was good. Market price of BARI hybrid seed was low compared to import one. They are interested to cultivate BHM 9 in next time. But seed was not available in the local market and little bit marketing problem occurred.

Adaptive trials of BARI khoibhutta 1 (pop corn) at Khagrachari hill district

The experiment was carried out at the farmer's field of Ramgarh char, Matirangaupazilla and on station (Hill Tracts Agricultural Research station) under Khagrachari hill district during Rabi season of 2014-15 to evaluate the field performance of BARI khoibhutta 1 (pop corn) to popularize pop corn variety to the farmer's and cultivate under charland and hill valley condition. BARI khoibhutta 1 (pop corn) was tested at different locations. Results indicated that BARI khoibhutta 1 (pop corn) performed better in Research field and produced the highest grain yield (3.50 t/ha) followed by matiranga and char land. The yield of pop corn varies 2.96-3.50 t/ha in different position and also yield loss due to excessive rainfall at maturity stage.Farmers not interest to cultivate pop corn due to lack of marketing facilities and seed unavailability.

Performance of BARI released mango varieties in Chittagong hill tracts

A performance experiment was conducted at the existing seven years old mango orchard containing BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4 and BARI Aam-8 at hill valley of Hill Agricultural Research Station of Raikhali in Rangamati Hill District during 2014-15. The maximum plant height (576 cm), base girth (75 cm), number of fruits per plant (425.3), fruit length (12.5 cm) and yield (44.1 t/ha) were observed in BARI Aam-8. The lowest number of fruits per plant (153.0), edible portion (71.6%) and fruit yield (6.3 t/ha) were found in BARI Aam-1. The heaviest fruit (443.7 g) and the highest edible portion (81.2%) were found in BARI Aam-4. The maximum TSS (16. 7%) was recorded in BARI Aam-3 and the minimum (13.0%) in BARI Aam-2.

Based on number of fruits per plant and fruit yield with higher TSS, individual fruit weight, fruit volume, edible portion BARI Aam-8 and BARI Aam-4 were superior among all other varieties under study in Chittagong Hill Tracts. Though, BARI Aam-2 and BARI Aam-3 were found to be promising for their satisfactory yield in CHT. BARI Aam-1 was suggested as suitable early sweet variety.

Effect of NPK 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), $T_9 = N_{230}P_{80}K_0S_{36}$ (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 during 2014-15 to find out the appropriate dose of fertilizer for better growth and yield of BARI Kola-3 in hill valley of Chittagong Hill Tracts. Control treatment showed the poor performance in all the parameter. Treatment T_{11} produced maximum base girth (54.83 cm) and leaves per plant (15.50).

Evaluation of grape (*Vitis sp.*) in hilly area

An experiment on the evaluation of grape in hill valley was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2014-15. The VLRai001 produced 191 bunch per plant with 53.47 fruits per bunch each fruit weighing 3.16 g containing 2.60 seeds per fruit. Edible portion and TSS were 84% and 15.6%, respectively. Fruit yield was 7.82 kg per plant and organoleptic taste was very sweet.According to the performance of TSS, organoleptic taste and other parameters, the VLRai001 was found as suitable for cultivation in hilly areas and might be released as sweet grape variety in Bangladesh for commercial cultivation.

Evaluation of grafted mandarin (*Citrus reticulata* blanco) in hilly area

An experiment was conducted at six years old grafted mandarin orchards consisting of ten genotypes in Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2014-15. The maximum number of fruits per plant (543) was observed in CRRai031 followed by CRRai022 (499) and CRRai023 (363), whereas there were no fruits in CRRai029. The time to first flowering was March in all the genotypes except CRRai025 where first flowering happened in February.The mandarin genotype CRRai031, CRRai022 and CRRai023 were supposed to be superior for number of fruit set and this experiment is ongoing.

Collection and evaluation of pumpkin lines during winter season at hill valley

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2014-15 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 node order of first female flower (NFF), fruit length(FL), fruit girth(FG), flesh thickness(FT), individual fruit weight(IFW), yield and TSS(%). Of these, NFF ranged from 16.3-24.3, FL 8-44, FG 43-97, FT 2.3-6.4, yield (t/ha) 9.62-17.40 and TSS(%) 6-12.5. Minimum node order of first female flower (16.3) was observed in CMRai001 which was statistically similar to CMRai003. The highest yield (17.40 t/ha) was found in CMRai010 followed by CMRai013 (17.38 t/ha) and lowest (9.62 t/ha) was found in CMRai001 treatment.According to the performance of all the genotypes CMRai001, CMRai002, CMRai004, CMRai006, CMRai008, CMRai010, CMRai012 and CMRai013 were found promising for this first year. All of them were selected for further confirmation of their performance in next year.

Effect of NPKS on the growth and yield of broccoli

A field experiment comprising fourteen fertilizer treatment viz., $T_1 = N_0P_0K_0S_0$, $T_2 = N_0P_{50}K_{80}S_{24}$, $T_3 = N_{70}P_{50}K_{80}S_{24}$, $T_4 = N_{140}P_{50}K_{80}S_{24}$ (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 2014-15 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 (8.88 t/ha) was observed in T_{14} treatment and lowest (4.60 t/ha) in T_6 treatment followed by control treatment. In both the low yielded treatment phosphorus was nil. According to this first year experiment result we can conclude that the optimum fertilizer for BARI Broccoli-1 cultivation could be $N_{140}P_{75}K_{40}S_{36}$.

Adaptive trial with BARI hybrid maize varieties in hilly areas

The trial was conducted at dalupara hill valleys in Bandarban during 2014-15 to compare the performance of BARI developed hybrid maize varieties with commercial maize cultivars. Four varieties were evaluated. NK 40 gave the highest yield (9.78 t ha^{-1}) followed by BHM-9 (9.32 t ha^{-1}). BHM-5 gave the lowest yield (8.12 t ha^{-1}).

Farmers opined that higher grain yield is their major demand and hence they choose NK 40 and BHM-9. The good quality and color of the varieties also attract the farmers.

Validation of chilli and hybrid maize under different planting systems in hilly areas

The experiment was conducted at OFRD, Bandarban during rabi season of 2014-15 to find out suitable systems of hybrid maize and chilli intercropping system and to study the effect of intercropping on component crops and increase total productivity and economic return. Two intercropping combinations viz., Maize single row (100 cm x 25 cm) + 2 rows chilli (50cm x 40cm) and Maize single row (150 cm x 25cm) + 3 rows Chilli (50cm x 40cm) were evaluated against their sole crops. Cob yield of hybrid maize and green fruit yield of Chilli was the highest in respective sole crops. The highest gross return (Tk 1,62,500 /ha), gross margin (Tk 1,12,500/ha) and benefit cost ratio (3.25) were recorded in maize single row (150 cm x 25cm) + 3 rows Chilli (50cm x 40cm) combination. The results revealed that maize single row (150 cm x 25cm) + 3 rows Chilli (50cm x 40cm) combination might be suitable and economically profitable for the hilly areas.Considering Cob yield, fodder yield and fruit yield of hybrid maize-chilli intercropping systems, Maize single row (150 cm x 25cm) + 3 rows chilli (50cm x 40cm) combination might be suitable for the hilly areas.

On-farm trial of bari developed country bean variety

A field experiment was conducted in Bandarbansadar areas during the rabi season of 2014-15 to evaluate the performance of different sheem varieties. The highest yield 14.54 t ha^{-1} was obtained from the variety BARI sheem-6 while local variety gave the lowest yield 11.36 t ha^{-1}.Farmers were interested to grow BARI sheem-6 due to its higher yield and noldoc shape pod.

On-farm trial of garlic varieties

A field trial was conducted at Bandarban during rabi, 2014-15 to evaluate the performance of modern garlic varieties in field condition. Results revealed that modern BARI varieties provided around 25% higher yields over the local one. BARI Rashun-2 was accepted to the farmers due to better yield and short duration.Farmers' reaction was very positive to BARI Rashun varieties against local due to its higher yield and profit. They have chosen BARI Rashun-2 due to its short days to maturity.

On-Farm trial of BARI developed tomato varieties

The experiment was conducted at Bandarban during rabi, 2014-15 to evaluate the performance of newly developed BARI tomato varieties among the farmers field. The highest yield 87.36 t ha^{-1} was obtained from the variety BARI tomato-14 while local variety gave the lowest yield 67.52 t ha^{-1}.Farmers preferred both BARI Tomato-14 and BARI Tomato-15 because of its yield as well as gross margin is higher compared to local variety.

On-Farm trial of Bari developed winter hybrid tomato varieties

The experiment was conducted at Bandarban during rabi, 2014-15 to evaluate the performance of BARI released hybrid tomato varieties at farmer's field. BARI Hybrid Tomato-5 produced the highest fruit yield.Farmers are very much interested to grow the BARI Hybrid Tomato-5 for its higher yield, uniform size, attractive color and reasonable economic benefit.

Sapling distribution during 2014-2015

Name of station	Number
HARS, KHAGRACHARI	35865
HARS, Ramgarh	29430
ARS, Raikhali	28972

20 SEED TECHNOLOGY

Effect of phosphorus level and mycorrhizal association on seed yield and quality of Garden pea

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Jaydebpur, Gazipur, during *rabi* season of 2014-15 to find out the optimum phosphorus level and mycorrhizal association for quality seed production of Garden pea (var. BARI Motorshuti 3). The experiment was laid out in split plot design with two mycorrhiza treatments viz., M_O= Without mycorrhiza and M_1= With mycorrhiza and four levels of phosphorus (P) viz. P_0= control, P_{20}= 20 kg P, P_{40}= 40 kg P and P_{60} = 60 kg P in the form of TSP. Dry matter production, plant height, number of branches per plant, number of pods per plant, number of seeds per pod, number of seeds per plant, 100- seed weight and finally seed yield were significant under different levels of phosphorus fertilizer. After harvesting, the seed germination, root length, shoot length, Seedling dry weight and seed vigour index were significant under different levels of phosphorus fertilizer and mycorrhiza. The tallest plant and seed per pod was found when 20 kg P was used. The yield and other yield contributing parameters were significantly highest where 40 kg P was used in the experimental plot. Maximum seed germination rate and seed vigour index were recorded from P_{40} treatment. Root length, shoot length and seedling dry weights were recorded highest from P_{20} treatment. From the study it was observed that in most of the cases 20 kg phosphorus with mycorrhizal association gave the highest seed yield and seed quality parameter of Garden pea.

Seed quality of wheat under conservation agriculture based technology

The experiment was carried out at the research field of Regional Wheat Research station, Shyampur, Rajshahi during rabi season of 2014-15 to find out the suitable conservation agriculture based technology for wheat seed production (var. BARI Gom 26). The experiment was laid out in a RCBD in with three replications. The treatment comprises four conservation agriculture based technologies viz. CA_0= conventional tillage, CA_1= strip tillage, CA_2= power tiller operated seeder and CA_3= raise bed system. Spike length, number of grain per spike, 1000 seed weight and seed yield were significant with different conservation tillage practices. The highest spike length, number of spike per square meter, floret no, number of grain per spike, thousand seed weight and finally seed yield were found maximum from T_4 (CA_3: raise bed system). After harvesting, significantly highest seed germination (94%), root length, shoot length, seedling dry weight and vigour index were recorded from the seed of raised bed system.

Increase nitrogen use efficiency in wheat seed production by using digital image analysis system

Wheat yield is extremely influenced by nitrogen (N) fertilization. The production and application of N fertilizers need large quantity of energy and excess is harmful to the environment; therefore, increasing plant N use efficiency (NUE) is essential for the improvement of sustainable crop production. This study investigates the accumulation and partitioning of dry matter (DM) and N use in a wheat variety in different nitrogen doses and to develop a nondestructive method for monitoring wheat growth and N status using digital camera. Four wheat varieties (BARI Gom 26, BARI Gom 28, BARI Gom 29 and BARI Gom 30) with four levels of nitrogen (N_0= 0 kg/ha, N_1= N50 kg/ha, N_2= N100 kg/ha and N_2= N150 kg/ha). Leaf SPAD values and dry matter were measured at different growth stages. Digital photo were taken of the wheat canopies at different growth stage. 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 aboveground total dry matter were most precise, the coefficients of determination (R^2) 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 R^2 value of 0.926 and an RMSE value of 1.631 g m^{-2}. In conclusion, as a near-ground remote assessment tool, digital cameras have good potential for monitoring wheat growth.

Effect of harvest fruit storage period on seed quality of pumpkin

A field experiment was conducted at the research field of Seed Technology Division, BARI, Joydebpur, during December 2014-April 2015 to evaluate appropriate post harvest fruit storage period for quality seed production of Pumpkin (var. BARI Misti Kumra 2). Seed quality was observed just after harvest (zero day storage) and after 1 month storage of pumpkin fruit (1st month storage). The seed of 1st month stored fruit gave better quality in terms of germination per cent, seedling dry weight and vigour index. Seed quality parameters were analysed up to one months of storage.

Effect of priming with phosphate solutions on seed yield and quality of maize

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur, during rabi season of 2014-15 to find out the **e**ffect of seed priming with phosphate solutions on seed yield and quality of maize (var. BARI Hybrid Maize 9)**.** The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Eight treatments were i) T_1= Dry seed (control), ii) T_2 =Water primed in (16 hours), iii) T_3 = SSP (1% P), iv) T_4 = SSP (1% P) + 20 g L^{-1} KOH, v) T_5 = SSP (1% P) + 25 g L^{-1} KOH, vi) T_6 = DAP (1% P), vii) T_7 = DAP (1% P) +15 g L^{-1} KOH and viii) T_8 = DAP (1% P) +20 g L^{-1} KOH. Plant height, number of grains per cob, grain weight per cob, cob yield (kg/plot), grain yield (kg/ha), thousand grain weight and shoot height were significant with different priming solutions. Yield of maize was also increased in response to P priming showing significant results in cob yield and grain yield. Priming maize seed with SSP (1% P +20 g L^{-1} KOH produced significantly higher grain yields over other treatments. The lowest grain yield was found in control treatment.

21 VERTEBRATE PEST

Development of management package against squirrel damage in coconut trees

The experiment was conducted at RWRS, Shyampur, Rajshahi during December 2014 to May 2015 to find out the suitable management tactics to reduce squirrel damage in 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 (10g) + hot chili (5g) + green chili (10g) 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 (100g) 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 chili (10g) + green chili (10g)) 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 percent fruit damage caused by squirrel were recorded up to 7 days after the application of the treatments of every interval.

All the treatments significantly reduced the squirrel infestation and repelled the squirrels from the trees over the control. The number of squirrels reaching on the tree canopy numerically differed among the treatments but no significant. In case of metal sheet wrapping trees, no squirrel could reach on the top of the tree canopy followed by human hair treated trees where only 1.50 numbers of squirrels could reach on the top of the tree canopy. It should be mentioned that human hair could completely repel the squirrels from the tree up to 12 days. After 12 days its repellency action might have been reduced for this reason some squirrels could move to the tree canopy. In case of homemade spray application (onion + hot chili + green chili), average 3.57 numbers of squirrel could reach to the tree canopy. Spray materials could maintain their pungency up to only 4 to 5 days. So, after 5 days, squirrels could move to the tree canopy and damage the fruits freely as well. No damaged coconut fruit was found (0.00) in wrapping metal sheet treated trees. The highest number of healthy fruits (32.00) were found in wrapping metal sheet treated trees due to no infestation caused by squirrels, followed by hanging of human hair treated trees (28.50) and homemade spray (onion + hot chili + green chili) treated trees (24.00) respectively and the lowest number of healthy fruits (11.00) were found in untreated control trees. In case of fruit damage no fruit damage (0.00%) was found in metal sheet treated trees followed by hanging of human hair treated trees (12.58%) and homemade spray (onion + hot chili + green chili) treated (24.19%) trees respectively. The highest fruit damage (66.15%) was found in untreated control trees. From this experiment, it has been revealed that wrapping metal sheet application has been able to repel squirrel significantly because squirrels were slipped and fall down while trying to climb on the trees.

Survey on bird damage in sprouting wheat in different wheat growing areas of Bangladesh

The questionnaire survey and visual observation on bird damage in sprouting wheat was conducted in 2 villages from the district Pabna and 2 villages from Dinajpur and 2 from Kaharole in Dinajpur district during 2014-15 to know the extent of damage by birds in sprouting wheat. Questionnaire survey on bird damage in sprouting wheat in farmers field was conducted among randomly selected 30 farmers from Pabna, 32 farmers from Dinajpur sadar and 28 farmers from Kaharole upazilla in Dinajpur district. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different questions 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 2014. The farmers who actually worked in the farms during these seasons are selected for the questionnaire. It is also an important tool for understanding the extent of awareness about birds as part of the agro eco-system. Learning the traditional and modern techniques used 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.

Many bird species 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 are acute and most of the farmer opined that bird is serious problem during sowing time of wheat. Maximum farmers expressed their opinion that pied myna (100%) is the most serious pest in sprouting wheat followed by common myna (83%) and jungle crow (66%), jungle crow was also serious problem near the urban area. Among the 90 farmers (30 from Pabna 32 from Dinajpur sadar and 28 from Kaharole), 100% farmers opined that birds are major problems in sprouting wheat. Pied myna, common myna, crow are the most serious pest in wheat. Maximum bird damage occurs between 10-15 days after sowing and damage ranges from 30–50 percent. Birds are not serious problem in ripening stage of wheat. Farmers use different control techniques for controlling bird and common techniques are repelling and use of poison.

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 research fields, BARI campus and storage of the different crop research centers and other divisions of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2013-14 and 2014-15 to estimate their damage severity. 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 AM to 5:00 PM 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 (5%) 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 Wheat and barley crops were found to damage lesser bandicoot rat (*Bandicota* *bengalensis*) at the tillering stage and maximum damage about (8% tiller) was observed at the booting or panicle initiation stage. Maize crop was damaged by crow (20-30/field) while sunflower crop was damaged by a number of parakeet (10-12/field) at maturity stage of the crop.

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 and other Substations named RARS, 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 during 2013-14 and 2014-15 to know the pest species, population, incidence, nature and extent of damage. Observations were made on the fruit trees namely mango, coconut, jackfruits, litchi, guava, sapota, ber, bael, tamarind and other fruit trees and forest wood trees. The number of fruit trees which were observed for squirrel was 20 in number in each varieties and locations. The survey work was conducted among the farmers in the prelisted questionnaires in different location through in interview schedule. Sometimes different types of live traps were set in the research farms, fruit garden, farmer's 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, 2014 to March, 2015 at 30 days intervals. Necessary information with photographs was taken carefully for documentation and presentation in the seminar, symposium and workshops. Incidence, nature of damage and extent or amount of damage by the different vertebrate pests were also observed carefully and recorded per plant basis.

Three species of squirrel viz. five stripe (*Funambulus pennanti*), three stripe (*Funambulus palmarum*), and brown squirrels (*Callosciurus pygerythrus* G) were found to damage different fruits namely mango, jackfruit, guava, litchi, sapota, ber, wood apple and tamarind. 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 different region of Bangladesh,. namely RARS Jessore, ARS Daulatpur and Fruit Research Satation Rajshahi. While the above mentioned fruits were damaged by a good number of brown squirrels (*Callosciurus pygerythrus* G)(0.5-1.50/plant) in the RARS Akbarpur, Hathazari, Chittagong, RHARS Khagrachari, HARS Ramgarh, The maximum damage of fruits (about 5-10%) caused by the squirrels were observed during April-June when the fruits were premature and matured condition.

Study on the status of black rat, *Rattus rattus* on coconut and its eco-friendly management technique at southern part of Bangladesh

The status of black rat *Rattus rattus* on control coconut and its management techniques were conducted at the Regional Agricultural Research Station, Rahmatpur, Barisal and at the farmers field of Lebukhali, Patuakhali during 2013-14 and 2014-15 to know the status of black rat and to develop an eco-friendly and cost effective management technique for controlling this pest. Five treatments were T_1: Barrier by metal sheet, T_2: Barrier by aluminium foil, T_3: Trapping (Snap/Kill), T_4: Acute poison (Zn Phosphide 2%) bait, T_5: Sanitation (clean management) and T_6: Untreated control were trialed. The experiments were laid out in randomized complete block design with five replications. One tree was served as one replication. The treatments were randomly allotted in each block. Trees with average age (10-12 years) and green nuts (25-30 days) were considered for study. Total trees of the selected farmers and farms were divided into five groups and data were recorded every alternate day on number of damaged and healthy nuts per tree. Percent damaged nuts were calculated in different treatments. The groups (10 trees/group at RARS, Rahmatpur and 5 trees/group at Lebukhali) were categorized based on plant height, age and damaged nut. Metal sheet (2 x 5ft) and aluminum foil (2x5ft) were wrapped around the tree trunk 3 ft above from the ground. A Snap/kill trap was set at the base of the coconut tree per plant with palatable food (dry fish and biscuits mixtures). Numbers of trapped rats were checked and recorded every day.

The average nut damaged by black rat in coconut was 22.71% at the RARS, Rahmatpur and 30.97% at the farmer's field of Lebukhali, Patuakhali. Among the treatments metal sheet (2x5ft) was wrapped around the tree trunk 3 ft above from the ground as barrier reduced the highest nut damage 89.57% at the RARS, Rahmatpur and 85.25% at Farmers field of Lebukhali, Patuakhali followed by barrier of aluminum foil 76.30% and 74.79% at RARS, Rahmatpur and Farmers field in Lebukhali, Patuakhali respectively in 2014 and 2015.Farmers have understand the technique that the tree's canopy to tree's canopy distance should be maintained (min.3 ft) and therefore metal sheet gave the best result. Significantly the nut damage increase 13.4% and 11.43% in 2013-2014 and 2014-2015, at RARS, Barisal and 12.15% and 17.25% in 2013-2014.

22 POSTHARVEST TECHNOLOGY

Effect of blanching on the quality of frozen carrot

Carrots *(Daucus carota* L) were collected from the local market of Joydebpur, Gazipur and transported to the postharvest laboratory of BARI, Gazipur. Edible fresh carrots were selected which were free from diseases and peeled, and cut in 1cm^3 pieces. Water blanching was performed in hot water at temperature ranged from 75 to 85 ^{0}C. Then the product was cooled in distilled water and vacuum packing was done. Finally, the product was stored at the laboratory deep freeze (-18^{O}C). The experiment was started from the month of February in each year and the products were stored for the next 4 months and the shelf life studies were continued at 1 month interval.

Treatments

T_1 = control

T_2, T_3 and T_4 = blanching at 75^0 C, 80^0 C and 85^0 C for 2 min, respectively

T_5, T_6 and T_7 = blanching at 75^0 C, 80^0 C and 85^0 C for 4 min, respectively

T_8, T_9 and T_{10} = blanching at 75^0 C, 80^0 C and 85^0 C for 6 min, respectively

Measurement of ascorbic acid, total soluble solids (TSS), P^H and titratable acidity

For ascorbic acid (vitamin C) measurement 10g sample was homogenized in 50 ml of 3% cold metaphosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2, 6-dichlorophenolindophenol titration following the method of Ranganna (1986). Ten milliliters of aliquot was titrated with 0.1% 2, 6- dichlorophenolindophenol solution until the filtrate changed to pink colour persisted for at least 15 seconds and the titration volume of 2, 6-dichlorophenolindophenol was recorded. Prior to titration 2, 6- dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2, 6- dichlorophenolindophenol and results were expressed as mg 100gm^{-1} fresh weight.

Again, 10g sample was homogenized in 50 ml of distilled water for 2 min using a kitchen blender and filtered through Whatman filter paper No. 2. The supernatant was collected to measure TSS using a digital refractometer (Model NR151) and expressed as percentage p^H was measured using a glass electrode p^H meter (Delta 320, Mettler, Shanghai) and titratable acidity was determined by titration with 0.1 mol L^{-1} NaOH to p^H 8.1 according to the method by Ranganna (1986) and expressed as citric acid (%).

Measurement of β-carotene

The estimation of β-carotene was done by the extraction of 3g product sample with acetone (Fisher Scientific Ltd., Uk) and petroleum ether. It was further purified with acetone, metabolic KOH and distilled water. The resulting solution was filtered with anhydrous sodium sulphate and read on a spectrophotometer (T-80, PG Instrument Ltd., UK) at 451nm against petroleum ether as a blank. A standard graph was plotted using synthetic crystalline β-carotene (Fluka, Germany) dissolved in petroleum ether and its optical density was measured at 451 nm (Alasalvar *et al.* 2005).

The experiment consisted of ten treatments and all ten treatments were replicated three times. The data were analyzed for ANOVA in completely randomized design (CRD) under computerized statistical methods of M-stat and Duncan's Multiple Range Test (DMRT) was used to compare the means.

The processed carrots were stored in refrigerator for four months. The chemical compositions were analyzed in every month. The experimental data were analyzed and presented in the following section. β-carotine and vitamine C are quality parameters that are typically assessed for fresh products, immediately after blanching and after a specific storage time.

The β- carotene contents of fresh carrot were found 87.89 and 85.47 μg/100g for the year 2013-2014 and 2014-2015, respectively, but the content was decreased at blanched condition. At blanching, the changes of β- carotene contents were increased after increasing the blanching time and temperature; these were decreased at the same rate after storage time increased. For both in the year of 2013-2014 and 2014-2015, the β- carotene contents were observed more after blanching at 85^0C with 4 min duration. Whereas, the vitamin C contents of fresh carrot was found 4.0 and 3.6 mg/100g for the year 2013-2014 and 2014-2015, respectively, but it was decreased after blanching with prolonged storage. The changes in Vitamin C contents of processed carrot were decreased after increased blanching time and temperature; and it was decreased at the same rates after storage time increased. Nutrients leached out from the product especially during water blanching. In addition, vitamins are degraded by heat. Vitamin C 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.

Blanching inactivates a portion of the enzymes and affects 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 85^OC using 2 min blanching time. Some enzymes persist at higher temperatures and are presumed to cause some of chemical changes in vegetables during storage in a freezer. 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. The blanching effect (temperature and time) and quality parameters comparision for the year of 2013-2014 and 2014-2015, it would be concluded that the treatment T_4 (blanching temperature 85^0c and time 2 min) with three month storage was found suitable. Therefore, carrots can be stored at home refrigerator using the above blanching condition for the three months.

From the investigations, it was found that the moisture content, acidity, P^H, β- carotene, vitamin C and TSS contents of frozen carrots were reduced during blanching with longer storage periods. The study results showed that the frozen carrots were stored well in home refrigerator up to three months with blanching at 85^0C for 2 minutes before storage.

Effect of blanching on the quality of frozen yard long bean

Yard long bean (*Vigna unguiculata* spp. *sesquipedalis*) was harvested from a farmer's field of Pubail, Gazipur and transported to the postharvest laboratory of BARI, Gazipur within one hour. Edible fresh yard long bean which were free from diseases were selected and peeled and cut into 20 mm pieces. Blanching was performed in hot water at temperature ranged from 90 to 95^{0}C. The product was them cooled in distilled water and vacuum packing was done. Finally, the product was stored at the laboratory deep freeze (-18^{O}C). The experiment was started from the month of May in each year and the products were stored for the next 4 months and the shelf life studies were continued at 1 month interval.

Treatments: There were eleven treatments:

T_1 = control, T_2 and T_3 = blanching at 90^0 C and 95^0 C for 2 min, T_4 and T_5 = blanching at 90^0 C and 95^0 C for 4 min, T_6 and T_7 = blanching at 90^0 C and 95^0 C for 6 min, T_8 and T_9 = blanching at 90^0 C and 95^0 C for 8 min, T_{10} and T_{11} = blanching at 90^0 C and 95^0 C for 10 min, respectively.

Measurement of ascorbic acid, total soluble solids (TSS), pH and titratable acidity

For ascorbic acid (Vitamin C) measurement, 10g sample was homogenized in 50 ml of 3% cold meta phosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2, 6-dichlorophenolindophenol titration following the method of Ranganna (1986). Ten milliliters of aliquot was titrated with 0.1% 2, 6- dichlorophenolindophenol solution until the filtrate changed to pink colour persisted for at least 15 seconds and the titration volume of 2, 6- dichlorophenolindophenol was recorded. Prior to titration 2, 6- dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2, 6- dichlorophenolindophenol and results were expressed as mg 100gm^{-1} fresh weight.

Again, 10g sample was homogenized in 50 ml of distilled water for 2 min using a kitchen blender and filtered through Whatman filter paper No. 2. The supernatant was collected to measure TSS using a digital refractometer (Model NR151) and expressed as percentage p^H was measured using a glass electrode p^H meter (Delta 320, Mettler, Shanghai) and titratable acidity expressed as citric acid (%) was determined by titration with 0.1 mol L^{-1} NaOH to p^H 8.1 according to the method by Ranganna (1986).

Measurement of β-carotene

The estimation of β-carotene was done by the extraction of 3g product sample with acetone (Fisher Scientific Ltd., UK) and petroleum ether. It was further purified with acetone, metabolic KOH and distilled water. The resulting solution was filtered with anhydrous sodium sulphate and read on a spectrophotometer (T-80, PG Instrument Ltd., UK) at 451 nm against petroleum ether as a blank. A standard graph was plotted using synthetic crystalline β-carotene (Fluka, Germany) dissolved in petroleum ether and its optical density was measured at 451 nm (Alasalvar et al. 2005).

The processed yard long bean was stored in refrigerator for four months in the year of 2014-2015. The chemical compositions were analyzed in every month.

The β- carotene contents of fresh yard long bean was found 83.32μg/100g but it was decreased at blanched condition and at prolonged storage. At blanching, the β- carotene contents were increased in same duration with higher temperature; and the β- carotene contents were decreased after increasing the blanching time at particular temperature condition up to three month of storage. Whereas, the vitamin C contents of fresh yard long beans was found 12.02 mg/100g but it was increased at blanched condition. During blanching, the vitamin C contents were increased and it was decreased at same duration with higher temperatures. The decreased rates were gradual when the storage time increased. Generally, blanching produces a decrease in the nutritional value of foods. Nutrients leached 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 because its high solubility and heat susceptibility make it a conservative indicator of nutrient retention. But, in some vegetables like green beans Vitamin C may retain more than even the fresh stuff.

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 vegetables 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 95^0C using 2 min blanching time. Some enzymes persist at higher temperatures and are presumed to cause some of chemical changes in vegetables during storage in a freezer. 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.

The blanching effect (temperature and time) and quality parameters comparision for the year of 2014-2015, it would be concluded that the treatment T_3 (blanching temperature 95^0c and time 2 minutes) with two month storage was found suitable. Therefore, yard long bean can be stored at home refrigerator using the above blanching condition for the two months.

The present study showed that the moisture content, acidity, p^H, β- carotene, vitamin C and TSS contents of yard long beans were changed on higher temperature with longer storage periods. From the investigations, it would be concluded that the frozen yard long beans were stored well in home refrigerator up to two months with blanching at 95^0C for 2 minutes.

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 made paste using grinder. Then this paste was held at room temperature for 1 hr in covered container to facilate enzymatic action for flavor and colour development. The pastes were treated with 0, 3, 6, 9, and 12% common salt and than citric acid (0.4%) were added to come down the P^H level around 4.0. The paste were thermally processed at 100^0C for 20 min in water bath and poured immediately in glass bottle, plastic container and aluminum foil package 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 while studied during storage.

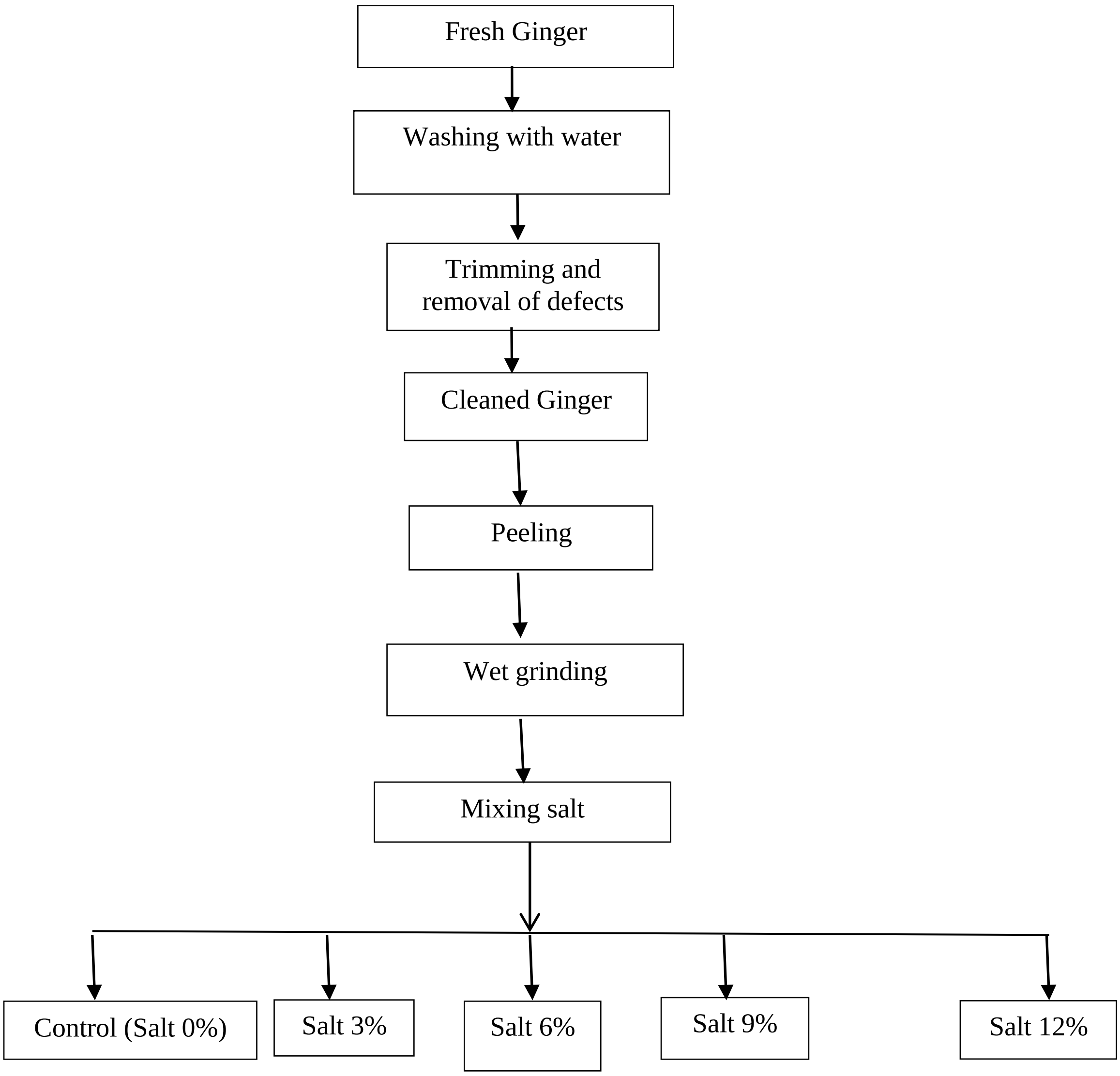


Fig. 1. Schedule of ginger paste preparation

Treatments

T_1,T_4,T_7,T_{10} and T_{13} =ginger paste in glass container in 0, 3, 6, 9 and 12% salt conc., respectively.
T_2,T_5,T_8,T_{11} and T_{14} = ginger paste in plastic container in 0, 3, 6, 9 and 12% salt conc., respectively.
T_3,T_6,T_9,T_{12} and T_{15} = ginger paste in aluminum foil packet in 0, 3, 6, 9 and 12% salt conc., respectively.

Measurement of titratable acidity, P^H and total soluble solids (TSS)

Titratable acidity in the processed paste was measured in terms of citric acid following the method described by Wang *e t al*. (1995). For measuring titratable acidity, 5 g paste were diluted with 95 mL distilled water making the volume to 100 mL, then filtered through Whatman no. 41 filter paper and titrated against 0.1 N NaOH to P^H 8.1 using phenolphthalein indicator. Acidity was expressed as percent citric acid by weight. The paste sample (5 g) was diluted with 45 mL distilled water, and P^H

was measured with glass electrode (EUTECH Instruments, Selangor, Malaysia). Sodium chloride was determined by titration with silver nitrate (Ranganna, 1986).

Total soluble solids (TSS) were determined with a digital bench top Abbe Refracto meter at 20^0C (Atago Co., Ltd., Tokyo, Japan). To determine TSS, the paste was dried under vacuum at 70^0C to constant weight. The dried samples were allowed to cool in desiccators for 30 min and then weighed (AOAC, 1995). Total solids (%) = (mass of dried sample mass of fresh sample) ×100

Measurement of Color

Color measurement was done by the method of Hunt (1991). Ginger–garlic paste color was measured and compared using a Hunter colorimeter model “Lab scan XE” (Hunter Associates Laboratory, Reston, VA) using universal software, based on three color coordinates namely L, a, and b. The instrument is calibrated using a standard white (L = 90.70, a = -1.08. b = 0.65) and blank reference tile under illuminated conditions such as “C” illumination and via angle 2°. The color values given by L, a, b is generally expressed as total color of the sample. “L” represents the lightness index, “a” represents red-green, whereas “b” represents yellow-blue color components.

Microbiological Analysis

Enumeration of coliforms, mesophilic aerobes, 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 45^0C were poured into plates and allowed to solidify. Set plates were incubated at 37^0C 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 27^0C for 3–4 days and colony count was recorded. All tests were carried out in duplicate and the average mean values are reported.

Statistical Analysis

Statistical analysis of the data obtained for each treatment was carried out by analysis of variance followed by Duncan’s new multiple range test to find out differences between treatments at the probability level of P <0.05.

The processed ginger paste was stored in ambient condition for four months in the year of 2014-2015. But, for the time being here showed only two months analyzed data. The experiment will be continued for the next two months.

Measurement of titratable acidity, P^H and total soluble solids (TSS)

At glass containers (GC), the acidity contents of the processed ginger paste were increased and p^H contents were decreased after increasing the storage life of the product although there were used in different salt percentages (Table 1). In most of the cases, the acidity content were increased when stored at longer period that means the P^H of the product might be lowered. As a result, when both the products were kept in plastic container (PC) and aluminum foil (AF) packed it would be spoiled after certain period.

The effects of different percentages of salt added and packaging materials for the changes in TSS of the processed ginger paste. It was noticed that in control conditions the TSS values were decreased using different packaging materials and increased storage life of the products. But, the processed ginger paste was kept and stored up to 2 months in glass container (GC) gives the significant increased results of the TSS although the salt percentages were increased. When stored in plastic container (PC) only the results of 3% and 12% salt TSS was little bit increased up to only one month of stored in ambient condition. Finally, the TSS values were decreased at different percentages of salt added when used of aluminum foil for kept and storage of ginger paste in ambient condition.

Measurement of surface colour

Color is an important factor in the perception of ginger paste quality. The changes in the paste color were monitored by estimating lightness (L^*), chromaticity co-ordinates a^* and b^* during storage at ambient condition. The values are presented in the Table 3 and it represented that the intensity of light yellow color of the ginger paste were gradually increased with extending the storage period and turned yellow as evidence by increasing values of L^* and changing values of a^* and b^* accordingly. The ginger paste under the control condition using glass container (T_1) to 12% salt in aluminum foil (T_{15}) represented a slower changes in the paste color as indicated more gradually increased in L^* and changing the values of a^* and b^* accordingly after 2 months of storage.

Microbiological Analysis

The effect of different percentages of salt added and packaging materials for the presence of microbial growth (bacteria, fungi, etc) in the processed ginger paste. It was noticed that in control conditions the microbial growth were seen using different packaging materials. But the processed ginger paste was kept and stored up to 2 months in glass container (GC) that gave the very good results with no presence of microbial growth using different salt percentages. When, it was processed and stored in plastic container (PC) the results of 3% salt showed no presence of bacteria up to 2 months but, 12% salt gave the good results only one month of storage in ambient condition. Finally, the presence of bacteria was seen at different percentages of salt when used of aluminum foil for kept and storage of ginger paste in ambient condition.

Table 1. Changes of acidity and P^H contents for the effect of salt and packaging materials of processed ginger paste in the year of 2014-2015

Treatment	Acidity and p^H content of processed ginger paste					
	Acidity (%)			p^H		
	Storage period, months					
	0	1	2	0	1	2
T_1= Control in GC	0.13	0.23	0.26	6.31	5.58	5.39
T_2= Control in PC	0.13	0.25	0.28	6.31	5.50	5.29
T_3= Control in AF	0.13	0.27	0.30	6.31	5.36	5.16
T_4= 3% salt in GC	0.36	0.32	0.31	4.1	4.20	4.25
T_5= 3% salt in PC	0.36	0.34	0.38	4.1	4.14	4.05
T_6= 3% salt in AF	0.36	0.39	0.41	4.1	4.00	3.95
T_7= 6% salt in GC	0.42	0.33	0.32	3.94	4.16	4.22
T_8= 6% salt in PC	0.42	0.45	0.51	3.94	3.90	3.85
T_9= 6% salt in AF	0.42	0.52	0.54	3.94	3.84	3.82
T_{10}= 9% salt in GC	0.47	0.37	0.32	3.89	4.09	4.12
T_{11}= 9% salt in PC	0.47	0.49	0.33	3.89	3.86	3.83
T_{12}= 9% salt in AF	0.47	0.52	0.55	3.89	3.84	3.79
T_{13}= 12% salt in GC	0.51	0.39	0.37	3.85	4.02	4.08
T_{14}= 12% salt in PC	0.51	0.39	0.41	3.85	4.00	3.96
T_{15}= 12% salt in AF	0.51	0.56	0.57	3.85	3.77	3.64

Note: GC= glass container; PC= plastic container; AF= aluminum foil packet.

The research will be continued for two years but this year has been presented only two months data. The study investigated the acidity and pH changes of processed ginger paste to evaluate the storage stability of the product using different salt percentages and packaging materials. The results revealed that the paste with 3% salt and kept in glass container showed better quality of paste in ambient condition. For more confirmation, this study will be came out next year.

Drying characteristics of jute leaf

The jute seed was collected from BINA, Mymensingh. Then it was planted in our laboratory field. When the leaf age was 40 days, the leaf was collected and dried. The variety was Bina patshak 1

Drying method

The drying of Jute leaf was conducted using the two method 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 passing through a heater and then across the trays of products for drying. The velocity of air was recorded (0.6 m/sec) by an Anemometer.

To conduct drying experiments the jute leaves were 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). 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 hour, temperature -76^0 C and vacuum was 0.001 milibar.

Treatments

T_1 = cabinet drying at 45^{0}C, T_2 = cabinet drying at 55^{0}C, T_3 = cabinet drying at 65^{0}C, and T_4 = freeze drying.

Measurement of ascorbic acid, total soluble solids (TSS), P^H and titratable acidity

For ascorbic acid measurement, 10g sample was homogenized in 50 ml of 3% cold metaphosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2, 6-dichlorophenolindophenol titration following the method of Ranganna (1986). Ten milliliters of aliquot was titrated with 0.1% 2, 6-dichlorophenolindophenol solution until the filtrate changed to pink colour persisted for at least 15 seconds and the titration volume of 2, 6- dichlorophenolindophenol was recorded. Prior to titration 2, 6- dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2, 6- dichlorophenolindophenol and results were expressed as mg 100gm^{-1} fresh weight.

Again, 10g sample was homogenized in 50 ml of distilled water for 2 min using a kitchen blender and filtered through Whatman filter paper No. 2. The supernatant was collected to measure total soluble solids using a digital refractometer (Model NR151) and expressed as percentage p^H was measured using a glass electrode p^H meter (Delta 320, Mettler, Shanghai) and titratable acidity expressed as citric acid (%) was determined by titration with 0.1 mol L^{-1} NaOH to p^H 8.1 according to the method by Ranganna (1986).

Measurement of β-carotene

The estimation of β-carotene was done by the extraction of 3g product sample with acetone (Fisher Scientific Ltd., UK) and petroleum ether. It was further purified with acetone, metabolic KOH and distilled water. The resulting solution was filtered with anhydrous sodium sulphate and read on a spectrophotometer (T-80, PG Instrument Ltd and UK) at 451nm against petroleum ether as a blank. A standard graph was plotted using synthetic crystalline β-carotene (Fluka, Germany) dissolved in petroleum ether and its optical density was measured at 451 nm (Alasalvar et al. 2005).

Measurement Color

Color measurement was done by the method of Hunt (1991). The colour of fresh and dry jute leaf was measured and compared using a Hunter colorimeter model "Lab scan XE" (Hunter Associates Laboratory, Reston, VA) using universal software, based on three color coordinates namely L, a*, and b*. The instrument is calibrated using a standard white (L = 90.70, a* = -1.08. b* = 0.65) and blank reference tile under illuminated conditions such as "C" illumination and via angle 2°. The color values given by L, a, b is generally expressed as total color of the sample. "L" represents the lightness index, "a" represents red-green, whereas "b" represents yellow-blue color components.

Determination of Dehydration ratio

The dehydration ratio of both in cabinet drying and freeze drying of jute leaf was calculated by the following formula:

$$\text{Dehydration ratio} = \frac{\text{Weight of prepared material before drying}}{\text{Weight of dried material}}$$

Data analysis

The experiment consisted of four treatments and all treatments were replicated three times. The data were analyzed for ANOVA in completely randomized design (CRD) under computerized statistical methods of MSTATC and Duncan's Multiple Range Test was used to compare the means.

The experiment has been completed and some data were collected but the analysis was not done yet.

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. Full ripened, half ripened and matured green of BARI tomato 14 were investigated by applying vapor heat treatment at 55° C for the durations of 5,10 and 15 minutes. After applying vapor heat treatment 10 fruits in each treatment were kept at ambient storage condition where average temperature was 33° C and average relative humidity was 85%. For comparison and evaluations of twelve 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.

Effect on chemical properties

Total acidity of tomatoes at all stages (full ripened, half ripened and matured green) were affected by vapor heat treatment. Acidity decreased compared to non treated fruits at all stages and with the durations of exposed time of vapor heat and gradual reduction of total acidity ware observed in every case .Vitamin C content was slightly reduced after treatment in most cases, but gradually increased with the shelf life durations. In case of TSS% and pH slight reduction was observed after treatments. TSS percent was little bit reduced and pH increased with increasing the shelf life durations. 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.

Effect on physical properties

Weight loss (%) was 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. The highest weight loss (%) was observed in both cases of no treated and high duration of heating at all stages of tomato. The lowest weight loss (%) was observed in the lowest duration of vapor exposed for 5 minutes of both stages of half ripened and matured green tomato. Shrinkage took place rapidly in non treated full and half ripened tomato. Vapor heat effectively controlled shrinkage in case of matured green tomato.

Effects on decay and 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 which was treated for 5 minutes and the highest was observed in non treated full ripened tomato.

Effects on marketability

Full and half ripened tomato showed very 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 measurement marketable fruits (90%) were observed at matured green stage which was treated for 5 minutes and the lowest at non treated in all stages.

Matured green tomato and pre storage vapor heat treatment at 55^0C for 5 minutes are suitable for storage of tomato at ambient condition.

Effect of waxing and temperatures on the postharvest quality of pineapple during storage

Pineapple fruits (*Ananas comosus* cv. Honey Queen) (at ripeness stage 3) were selected on the basis of the uniformity of the color and size from a commercial grower in Naniarchar, Rangamati Hill district, Bangladesh. The stage of ripeness was determined by visual assessment of the shell (Selvarajah *et al.*, 2001). The scale ranges from 0 to 5: 0, all eyes are totally green; 1, < 20% of the eyes are predominantly yellow; 2, 20 to 40% of the eyes are tinged with yellow; 3, up to 65% of the eyes are predominantly yellow; 4, 65 to 90% of the eyes are fully yellow; 5, > 90% of the eyes are fully yellow and not more than 20% of the eyes are reddish orange. All fruits were cleaned and soaked in 0.05% (w/v) Iprodione solution (Rovral, FMG, Auto Crop Care Ltd, Bangladesh) for 2 min to eliminate potential microbes. Afterwards, the treated fruits were divided into ten groups; each group (10 fruits) was placed in a clean plastic box. The fruits of one group were dipped in water (as control). The fruits of nine groups were respectively treated with Sta-Fresh 2952 (FMC) wax solution at 30, 60 and 90 g/l. After air dried, the samples were placed in polyethylene bags (0.04 mm), stored at 9, 11 and 13°C and at 88±2% relative humidity (RH) for 21 days and transferred to 25°C for 3 days to simulate shelf conditions for chilling injury and quality evaluation. Five fruits from each box were randomly sampled to determine quality characteristics of fruits after storage periods and then the optimal treatment condition was chosen. Ninety fruits were treated with the optimal treatment and 90 fruits were dipped in water (control). All fruits were stored at 9, 11 and 13°C and some samples were taken at interval. After 21 days storage at 88±2% RH, the residual samples were transferred to room temperature (25 - 28°C) for three days storage. Five fruits from each box were randomly sampled every 7 days in cold storage and each day in room temperature (25 - 28°C) storage to determine physical and biochemical changes during storage period. The treatment combinations are as follows:

T_1= Sta-Fresh 2952 coating@ 30 g/l + 9^0C storage temperature, T_2= Sta-Fresh 2952 coating@ 30 g/l + 11^0C storage temperature, T_3=Sta-Fresh 2952 coating@ 30 g/l + 13^0C storage temperature, T_4= Sta-Fresh 2952 coating@ 60 g/l + 9^0C storage temperature, T_5= Sta-Fresh 2952 coating@ 60 g/l + 11^0C storage temperature, T_6= Sta-Fresh 2952 coating@ 60 g/l + 13^0C storage temperature, T_7= Sta-Fresh 2952 coating@ 90 g/l + 9^0C storage temperature, T_8= Sta-Fresh 2952 coating@ 90 g/l +11^0C storage temperature, T_9 = Sta-Fresh 2952 coating@ 90 g/l +13^0C storage temperature, T_{10} = Control

Chilling injury index (CI) determination

The fruits were cut longitudinally in the half and CI was determined. For each fruit, CI intensity was scored from 0 to 5 according to the percentage of flesh affected (0, free from CI; 1 to 5: 10, 10 to 25, 25 to 50, 50 to 75 and >75% of the flesh discolored, respectively) (Selvarajah *et al.*, 2001). The average CI was calculated for each group of fruit.

Firmness

Fruit firmness was measured at three regions of the flesh of each fruit at different storage times using a Digital Firmness Tester (DFT 14, Agro Technologies, France) equipped with 8 mm diameter stainless probe. Firmness value was expressed as a resistance force (kg-force/cm^2) of the surface and results were expressed as Newton (N).

Color assessment

Readings with colorimeter were randomly taken at three different locations on each pineapple fruit using a Digital Chroma Meter (Model CR-400, Minolta Corp and Japan). CIE $L^*a^*b^*$ coordinates were recorded using D65 illuminants and a 10° Standard Observer as a reference system. L^* is lightness, a^* (-greenness to + redness) and b^* (-blueness to + yellowness) are the chromaticity coordinates. The * and b^* values were converted to chroma [$C = (a^{*2} + b^{*2})^{1/2}$] and hue angle [$h = \tan^{-1}(b^*/a^*)$].

Sugar content and titratable acidity

Sugar content was estimated by the method of Ranganna (1994) and titratable acidity expressed as citric acid (%) was determined by titration with 0.1 mol L^{-1} NaOH to pH 8.1 according to the method by Ranganna (1994).

Total soluble solid

Total soluble solid in the extracted juice of fruits was measured by a refractometer (ATAGO (Brix = 0 to 32%) and the results were expressed as % Brix (Cheour *et al.*, 1991).

Ascorbic acid

For ascorbic acid measurement, 10g pulp tissue was homogenized in 50mL of 3% cold metaphosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2, 6-dichlorophenolindophenol titration following the method of Ranganna (1994). Ten milliliters of aliquot was titrated with 0.1% 2, 6-dichlorophenolindophenol solution until the filtrate changed to pink colour persisted for at least 15 seconds and the titration volume of 2, 6-dichlorophenolindophenol was recorded. Prior to titration 2, 6-dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2, 6-dichlorophenolindophenol and THE results were expressed as mg $100g^{-1}$ fresh weight.

Experimental design and statistical analysis

The experiment was laid out in a Completely Randomized Design (CRD) with three replications. The data were subjected to analysis of variance (ANOVA) using the R Statistical Software version R i386 3.1.2. Mean separation was done by Least Significant Difference (LSD) test at $P<0.05$.

Effect of different wax and storage temperature treatments on chilling injury index, firmness, color saturation, sugar contents and titratable acidity of pineapple fruits

After being stored at three different temperatures (9, 11 and 13°C) for 21 days and transferred to room temperature (25 - 28°C) for 3 days, the pineapple fruits treated with wax exhibited significantly ($P < 0.05$) lower levels of chilling injury index (CI) than that of the control fruits (Table 1), suggesting that wax at allied temperature may prevent chilling injury. The chilling index in fruits of the 5th treatment (at 11^0 C & @60 g/l wax) was the lowest in all samples. Titratable acidity (TA) levels in wax-treatments were lower than those in control. There were significant differences in the levels of total sugar between wax-treatments and control. Flesh firmness in wax-treatments was higher than that in control (Table 1), indicating that wax slowed down fruit softening process as well as pectin degradation. The color saturation for the wax-treatments was significantly higher than that in control ($P < 0.05$) and the highest color saturation of fruits was in the 5th treated fruits (Table 1). Therefore, a lower chilling index in the 5th treated fruits was observed. The 5th treatment was the optimal treatment.

Chilling injury index

Symptoms of chilling injury (CI), including internal browning and flesh mealiness were assessed visually. The CI of the fruits in control was higher than that in wax-treatment and the CI of the wax treatment was significantly lower than that in control ($P < 0.05$) after the 14th day of storage. The results indicated that wax treatment in combination with allied temperature could significantly decrease internal browning and flesh mealiness symptoms of pineapple fruits.

The results showed that all the three concentrations of wax treatment can effectively alleviate chilling injury of pineapple fruits and improve their quality after cold storage. The chilling injury indices of fruits were significantly affected by wax treatments and storage temperatures, with wax-treated fruits having a lower index than that of the control. Reuck *et al.* (2009) have also reported that coating was effective in alleviating chilling injury of litchi fruit. Wax treatment maintained firmness of pineapple fruits in a higher level than that in the control and this was similar to that observed by Martinezromero (2005).

Firmness

Loss of firmness is one of the main factors limiting quality and the postharvest shelf-life of fruits and vegetables. The firmness in control fruits decreased gradually along with increased storage time. Throughout storage, the loss of firmness of control was significantly greater than that of other treatment combinations, indicating that wax delayed the decline of firmness.

Colour

The color change of pineapple flesh can serve as an indicator of chilling injury and fruit quality. During color development, the chroma increased slightly from harvest to the 7th day of storage and then decreased sharply up to the 22nd day. It is clear that lower storage temperature and wax significantly reduced the decrease of the chroma during the storage period compared to that of the control ($P < 0.05$). Chroma is the intensity or purity of the hue and it shows the brightness of fruits. Therefore, wax treatment diminished the color brightness in comparison with control. After 3 day of storage, hue angle was higher in wax-treatment than in control and higher hue angle showed less browning and better quality based on Nunes *et al.* (1995), who reported less browning in fruits with higher hue angle. The effect of wax may be due to decreased respiration rate, which prevents fruit senescence during storage.

The effects of wax on fruits are associated with the source and concentration of wax, mode of wax application, types of fruits and storage conditions (Hernandezmunoz *et al.,* 2008). The results presented herein indicated that Sta-Fresh 2952 wax treatment (60 g/l concentration) was more effective than the other treatments in alleviating chilling injury index and retarding change of color saturation, the most important factor related to chilling injury in pineapple fruits. Similarly, other studies also observed that the beneficial effects of wax on other types of fruits were enhanced with increasing the wax concentrations (Hernandezmunoz *et al.,* 2008; Zhu *et al.,* 2008).

Changes in total sugars and titratable acidity (TA)

Levels of total sugars of pineapple fruits were significantly affected by the treatment combinations of waxing and lower temperature, with treatment combinations having higher levels of total sugars than control during most of the days of storage. The total sugar content was increased in wax-treatment by 18.37 and 15.39%, respectively at the 21th and the 24th day of storage, when compared with that in control. For TA, a steady increase was observed in both control and wax-treatment during cold storage. After 21 day of storage, TA contents of all fruits decreased at the later storage time .The wax treatment reduced TA by approximately 21.74 and 45.71% compared with the control at 14 and 21 day, respectively. These results indicated that wax treatment could reduce TA content of fruits in cold storage.

Fruit acidity and sweetness are two major factors that determine eating taste and quality of pineapple fruits. Wax treatment decreased significantly TA content of fruits, while it increased soluble sugars content after cold storage. This observation is similar to that reported by Sun *et al.* (2010), who observed that litchi fruits treated with chitosan coating tend to maintain significantly higher levels of sugars compared with the control fruits. Meanwhile, Eum *et al.* (2009) reported that the coatings of plum fruits slowed the TA changes. Together, these observations indicated that wax treatment not only could alleviate chilling injury, but also improve quality of pineapple in cold storage.

Changes in total soluble solid (TSS)

TSS of the fruits (control) rapidly increased on day 22 and then fell towards the end of storage period. The changes in TSS content were more slowly in wax-treatment than in control. The wax-treatment tends to maintain significantly ($P < 0.05$) lower levels of TSS than compared with that in the control during most days of storage (days 14, 21, 22 and 24).

Ascorbic acid (AsA)

The AsA content in the control decreased during the first 14 days and increased gradually in the 3rd week and then decreased again in the last three days of storage. The AsA content of the fruits in the treatment combinations decreased during the first 21 days of storage and increased gradually with prolonged storage time. Throughout the storage period, there were significant differences between control and wax-treatment ($P < 0.05$). The AsA content in wax-treatment was 3.88% higher than that in the control on the 24th day of storage.

Table 1. Effect of different wax treatments on chilling injury index, firmness, color saturation, contents of soluble sugars and titratable acidity of pineapple fruits after 21 day storage at 11°C followed by 3 day storage at room temperature (25-28°C.)

Treatment combinations	Chilling index	Firmness (N)	Color saturation (Chroma)	Total sugar (%)	Titratable acidity (%)
T_1= Sta-Fresh 2952 coating@ 30 g/l + 9^0C storage temperature	2.03b	2.07c	30.83b	7.00c	0.71e
T_2= Sta-Fresh 2952 coating@ 30 g/l + 11^0C storage temperature	2.03b	2.11c	30.89b	7.41b	0.72de
T_3=Sta-Fresh 2952 coating@ 30 g/l + 13^0C storage temperature	2.03b	2.11 c	31.03b	7.09bc	0.75cd
T_4= Sta-Fresh 2952 coating@ 60 g/l + 9^0C storage temperature	2.03b	2.08c	31.58ab	7.10bc	0.75cd
T_5= Sta-Fresh 2952 coating@ 60 g/l + 11^0C storage temperature	1.01c	2.31ab	33.10a	7.95a	0.76c
T_6= Sta-Fresh 2952 coating@ 60 g/l + 13^0C storage temperature	1.02c	2.13c	31.14b	7.20bc	0.80b
T_7= Sta-Fresh 2952 coating@ 90 g/l + 9^0C storage temperature	2.03b	2.09c	30.58b	7.20bc	0.77bc
T_8= Sta-Fresh 2952 coating@ 90 g/l +11^0C storage temperature	1.02c	2.29b	30.51b	7.10bc	0.78bc
T_9= Sta-Fresh 2952 coating@ 90 g/l +13^0C storage temperature	1.02c	2.39a	30.42b	7.31bc	0.80b
T_{10} =Control	4.06a	1.55d	30.37b	6.49d	1.40a

Means in the same column followed by different letters differ ($P < 0.05$) according to LSD test.

In terms of protection from marketable quality degradation of pineapple fruit like black heart rot and chilling injury during cold storage, results of the present study reveals that pineapple treated with 60 g/l Sta-Fresh 2952 wax and stored at 11^0C and 88±2%RH is an effective means. The changes occurred during storage, such as flesh colour, titratable acidity and fruit softening were markedly delayed, illustrating potential for commercial control of pineapple fruit storage. Proper postharvest treatment and minimum temperature had delayed the quality degredation process and prolonged storage life up to 24 days retaining desirable colour, texture and quality.

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 (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. The experiment was laid out in CRD with three replications. Each replication of the treatments consisted of one kilogram of bitter gourds. After packing, the bitter gourds were stored in ambient condition. Temperature and humidity were recorded and close observations were made to record the physicochemical parameters like weight loss, rotting/decay, marketability, vitamin C and ß-carotene of the bitter gourd.

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).

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. The perforations were to be 42, 83 and 124 for 0.5, 1.0 and 1.5%, respectively.

Firmness

Fruit firmness was measured at three regions of the flesh of each bitter gourd at different storage times, using a Digital Firmness Tester (DFT 14, Agro Technologies, France) equipped with 8 mm diameter stainless probe. Firmness value was expressed as a resistance force (kg-force/cm^2) of the surface and results were expressed as Newton (N).

Shelf life (day)

Shelf life of the bitter gourds was determined by observing and judging the quality parameters like rotting, shriveling, incidence of disease, etc. with respect to storage days. It was detected when most of the bitter gourds of a treatment were still marketable.

Decay/Rotting (%)

It is the percentage of the damaged bitter gourds. It was also determined by the quality parameters of the bitter gourds like rotting, shriveling, incidence of disease, etc.

Physico-chemical analysis

Vitamin C, ß-carotene and moisture content were determined for the fresh bitter gourds at 6^{th} to 9^{th} days of storage. Vitamin C (ascorbic acid) was determined by 2,6 – Dichlorophenol – Indophenol Visual Titration Method, ß-carotene by AOAC (Association of Official Analytical Chemists) Method and moisture content by Oven Drying method. These methods were conducted according to Ranganna (1986).

Data on physicochemical parameters (weight loss, firmness, vitamin C and ß-carotene) and rotting/decay as well as marketability of the bitter gourds were taken at 1^{st} through 5^{th} days of storage at ambient condition. Temperature was recorded during the experiment as $30^0 – 36^0$C (max.) and $27^0 – 29^0$C (min.) and humidity as 65% - 85% (at 9:00am) and 68% - 92% (at 4:30 pm).

The results showed that bitter gourd stored in packets maintained optimum weight loss, minimum rotting/decay and thus maximum marketability of the gourd as compared to that of control after 5 days of storage period (Fig. 1 to 4). The bitter gourd packed in 1.5% perforated packets (T_4) maintained minimum rotting/decay (5.88%) and thus maximum marketability (94.18%) followed by packet with 1.0% perforation (T_3) after 5 days of storage period (Fig. 2 & 4). Conservation of excessive moisture content resulted more condensed water in the T_1 packet and thus enhanced the rotting. On the other hand, bitter gourds kept in bulk without packaging (T_5) lost moisture drastically and shriveled rapidly. The storage of the bitter gourds in the polypropylene packets conserved the moisture that 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. 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.* (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 and ethylene production, as O_2 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. 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 (Alejandra Rojas-Grau *et al.*, 2009).

A substantial reduction was noted in 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 period the colour and pigments increased and thus increased the ß-carotene content. Vitamin C was highest (53.32 mg/100gm) in treatment T_4 followed by T_3 over the storage periods. Again, ß-carotene retention was highest (51.62 mg/100gm) in control followed by T_4 over the storage periods. These chemical and nutritional compositions and changing behaviors of the stored bitter gourds support to those found by Salunkhe (1991).

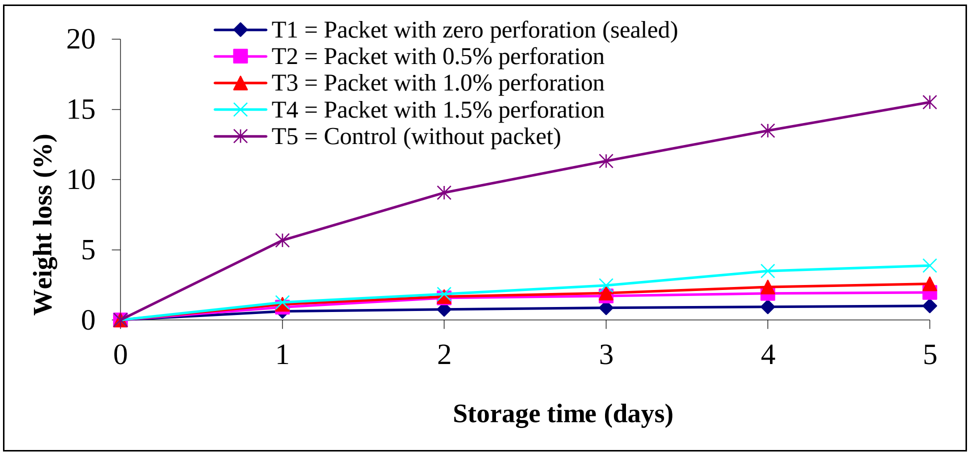


Fig. 1. Effect of perforated polypropylene packets on the weight loss of bitter gourd during storage at ambient condition (28-34^0 C).

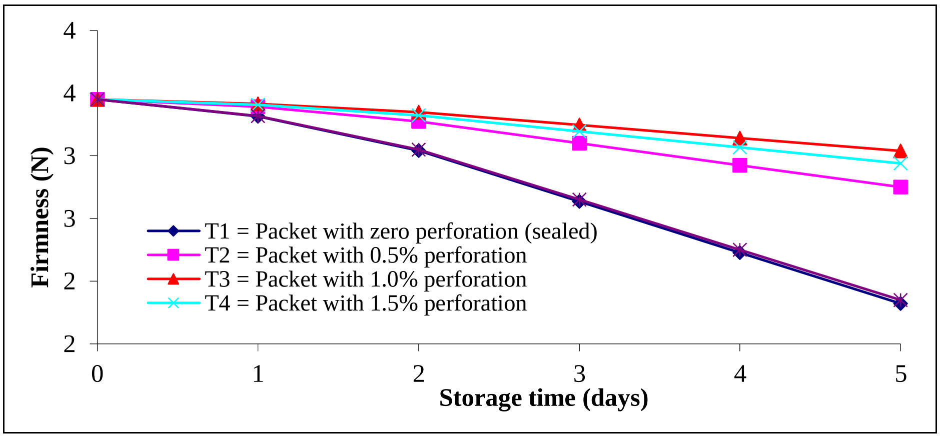


Fig. 2. Effect of perforated polypropylene packets on the firmness of bitter gourd during storage at ambient condition (28-34^0 C).

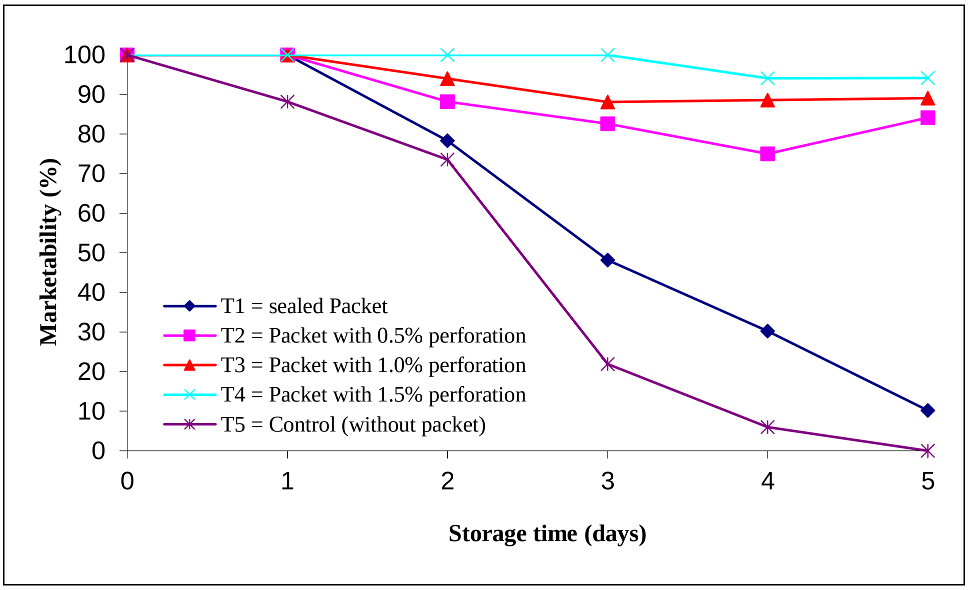


Fig. 3. Effect of perforated polypropylene packets on the marketability percentage of bitter gourd during storage at ambient condition (28-34^0 C).

Bitter gourd packed in 1.5% perforated polypropylene is better for quality and shelf life for 5 days of storage at ambient temperature considering its marketability and physiological changes.

Study on the sprouting behavior of potato using chemicals and some essential oils during storage

BARI Alu 25 was collected from Tuber Crops Research Centre, BARI, Gazipur and essential oils and chemicals are collected from market. Clay pots of capacity 2kg were purchased from local market. The clay pots were properly washed and dried before using in experiment. Potato sprout growth inhibition activity by the fumigation of essential oils were performed. Ten tubers/treatment were taken in clay pots with air tight condition. Various amount of essential oils and chemicals was taken in plastic vials without lid were placed inside clay pots for fumigation. The fumigation of essential oils and chemicals were allowed to the tuber as vapor for four weeks at room temperature (28-32°C) and the sprouting growth inhibition activity was monitored at seven days interval. Isopropyl-N-chlorophenyl carbamate (CIPC) was used as synthetic sprout control and a clay pot without any oils or chemicals was used as control. Essential oils and chemicals were used as per the following treatments:

Treatments

T_1= Control	T_2= CIPC 1.0 ppm	T_3= CIPC 2.5 ppm
T_4= CIPC 5.0 ppm	T_5= Clove oil 1.0 ppm	T_6= Clove oil 2.5 ppm
T_7= Clove oil 5.0 ppm	T_8= Mint oil 1.0 ppm	T_9= Mint oil 2.5 ppm
T_{10}= Mint oil 5.0 ppm	T_{11}= Lemon oil 1.0 ppm	T_{12}= Lemon oil 2.5 ppm
T_{13}= Lemon oil 5.0 ppm		

The experiment was laid out in Complete Randomized Design with three replications.

Initial tuber weight and weight loss after 1st, 2nd and 3rd weeks of storage are shown in Table 1. In 1st week maximum weight loss was observed in T_8 (Mint oil 1.0 ppm). After 2nd and 3rd weeks maximum weight loss was observed in T_6 (Clove oil 1.0 ppm). Maximum amount (20.0%) of potato was rotted under T_4, T_8 and T_{12} after 2nd weeks but after 3rd week highest potato loss was observed in T_{12} (33.3). In some cases, sprouting capability was inhibited by application of essential oils. Lowest amount of bud was sprouted (40.67) after 2nd week when Clove oil was introduced @2.5ppm (T_6) whereas highest 50.67%) was found in control (T_1).

After 1st week CIPC 1.0 ppm gave 21.09% positively control of potato sprouting and after 2nd week the treatment reduced upto 13.34% over control treatment. CIPC 5.0 ppm did not supress potato sprouting at 2nd and 3rd week after treatment application. After 07 days, the clove oil (2.5 ppm) positively influenced (24.34% over control) to inhibit sprout development behavior. After 14 days of treatment application Clove oil of 5.0 ppm showed the best over control but after 21 days the effect of 2.5 ppm clove oil performed maximum sprout suppression behavior over control than the others. It was observed all three concentrations of mint oil was able to positively inhibit the sprouting of potato. On the other hand, lemon oil of three concentrations showed positive effect at 1st week against sprouting. So it is clear that clove oil has sprouting suppression capacity by which it can be able to use as natural anti-sprouting agent in potato storage.

Sprout suppression during storage is ongoing concerns for potato growers. Although there are chemical control options for this problem, growers are seeking more effective and affordable options that are safe for the environment and the consumer. This experiment will be continued to evaluate including other "natural" products for their potential utility for maintaining the quality of stored potatoes.

Determination of formaldehyde in selected fruits and vegetables

Mango (cv. Khirshapat, Langra, Harajam, Amropali, Lakshmanvog and Dudhshar) were collected from mango growers' garden of Chapai Nawabjong. All varieties were analyzed in both ripe and over ripe condition to estimate naturally occurring formaldehyde in fruits. The analytical procedure was followed according to the method described in AOAC (Method 931.08). The method was as follows:

A. Preparation of test sample:

1. Take 100g solid sample
2. Add 100mL of distilled water
3. Blande
4. Transfer to distillation flask
5. Acidify with H_3PO_4 Add 01mLexcess.
6. Distilled slowly and collect 50mL.

B. Prepare Chromotropic acid solution:

1. Prepare standard solution of 1, 8-dihydroxynaphthalene-3,6-disulfonic acid (ca 500 mg/100 mL) in 72% H_2SO_4, Solution will be light straw colour.

C. Procedure:

1. Take 5mL reagent.
2. Add 1mL distillate.
3. Place in boiling water for 5 minutes. The solution will be turned into light to deep purple colour depending upon concentration of formaldehyde.
4. Measure absorbance at 574nm wave length.
5. Prepare 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 ppm standard formaldehyde solution for standard curve.

Estimation of formaldehyde in Mango: After full ripe and over ripe condition mango pulp tissue was collected and homogenized for formaldehyde estimation. It was observed that formaldehyde was detected both in full ripe and over ripe condition of fruits. At full ripe stage the highest level of formaldehyde was observed in cv. Dudhshar (2.38 ppm) followed by Harajam (1.52 ppm) (Table 1). Langra produced maximum level of formaldehyde (2.70 ppm) naturally when it reached over ripe stage. Formaldehyde was detected maximum in all mango varieties (Khirshapat, Harajam, Amropali1, Lakshman vog and Dudhshar) at full ripe stage than its over ripe condition except variety Langra (Table 1).

Table 1 Estimation of formaldehyde in mango pulp

Variety	Amount of formaldehyde (ppm)	
	Full ripe stage	Over ripe stage
Khirshapat	0.43 f	0.13 d
Langra	1.08 c	2.70 a
Harajam	1.52 b	1.09 c
Amropali	0.82 e	0.13 d
Lakshman vog	0.91 d	0.24 d
Dudhshar	2.38 a	1.91 b
CV%	5.4	9.76

It can be concluded that mango fruits naturally produce some amount of formaldehyde. More detail work will be done next year.

Preparation of rapid test kit for formaldehyde detection

Preparation of kit:

1. Solution-A: Take 4.4g Pheny-1-hydrazine hydrochloride in 40 mL distilled water and sonicate.
2. Solution-B: Take 4.4g Potassium hexacyanoferrate in 40 mL distilled water and sonicate.
3. Solution-C: Hydrochloric acid solution 50:50 ($HCl:H_2O$)

Procedure:

1. Rinse the sample with 10 mL distilled water.
2. Take 2 mL sample rinsed water in a test tube.
3. Add 2 drops of Solution-A and shake for at least 30 seconds.
4. Add 2 drops of Solution-B and shake for at least 30 seconds.
5. Now add 10 drops of Solution-C and shake again for 30 seconds.
6. Pink to purple colour will be developed depending on the presence of formaldehyde in test sample.

NB. Best use time limit for test kit: Under investigation.

Effect of ripening chemical application at different stage of maturity on postharvest quality of tomato

Fruits of BARI Tomato 14 with different physiological maturity and free from physical defects and insect infestation were collected from the experimental field of Post Harvest Technology Division and used for the study. The fruits were selected and grouped on the basis of uniformity, maturity and size. The fruits were washed with clean water and dried with air flow before use. According to the maturity, the tomatoes were divided into five groups like (T_1) control ripe, half ripe (T_2), breaker stage (T_3), mature green (T_4) and immature green (T_5), each group containing nine kg of tomatoes. Then each group was dipped in 750 ppm ethephon solution for five minutes except the control (T_1). The fruits of control treatment were dipped in the pure water for five minutes without using ethephon solution.

After that, the fruits were air dried at ambient temperature for 10 minutes to reduce possible chemical injury. Five tomatoes were drawn from each treatment after 3, 6 and 9 days of storage for their physico-chemical analysis. The samples were assessed for percentage of ripening, firmness (kg-f/cm^2), TSS (%), titratable acidity (%), ascorbic acid (mg/100g), total carotenoids (mg/100g) and pulp or juice content (%). Percentage of ripening was calculated as per the formula: ripening (%) = (the number of ripe fruit/total number of fruit) X 100 and expressed as a percentage. Titratable acidity (%), TSS (%) and ascorbic acid (mg/100g) were determined following the method described by Ranganna (2007). Firmness was measured by using a Digital Firmness Tester (DFT 14, Agro Technologie, France). Firmness value was expressed as a resistance force (kg-force/cm^2) of the surface. Measurements were taken at three different places of each tomato and mean was calculated.

Total carotenoid was measured by taking 5 grams of the sample, grounded with acetone and anhydrous sodium sulphate in a pestle and mortar (Ranganna, 2007). Total carotenoids (mg/100g) were measured by spectrophotometer (T-80, PG Instrument Ltd., and UK) at 451ηm (Alasalvar*et al.*, 2005). Total pulp recovery was determined by boiling the tomatoes and sieved to separate seeds, skin and pulp. Percentage of pulp was calculated by the formula: % pulp content = (collected pulp wt. / wt. of original tomato) X 100.

The experiment consists of five treatments which were replicated three times. The data were analyzed for ANOVA in completely randomized design (CRD) under computerized statistical methods of MSTATC and Duncan's Multiple Range Test was used to compare the means.

Effect on ripening: Present investigation revealed that the stage of maturity affects the onset of ripening in tomato. Tomatoes treated with ethephon (2-chloroethyl phosphonic acid) @750 ppm at half ripe, breaker stage, mature green and immature green were ripened, (100%, 83.85%, 61.65% and 52.81%, respectively) after 9 days of storage. But ripening percent found in control (full ripe tomatoes) was only 46.20%. It can be concluded that, the ripening process significantly varies with the stage of maturity.

Effect on firmness: The firmness of the tomato fruit declined with the days of storage which was found maximum in case of immature green tomatoes (0.23 kg-f/cm^2) and minimum in control (0.12 kg-f/cm^2) which was followed by breaker stage tomatoes (0.18 kg-f/cm^2). After that, firmness (kg-f/cm^2) was decreased in tomatoes with storage time in all treatments. It may be due to softening the texture for ripening process.

Effect on titratable acidity: Acidity of the tomato fruit was varied with the stage of maturity. Maximum total acidity was found in immature green tomato TSS (0.84%) and the minimum was found in control (0.47%) followed by half ripe stage (0.53%) The conversion of acid to sugar increases with the ripening process in each treatment. Similar finding was also noted in guava (Singh *et. al.*, 1979) and in date (Sarma and Singh, 1981). Riberau-Gayaon (1968) suggested that transformation of organic acids into sugars was one of the reasons for deceasing organic acids during fruit ripening.

Effect on total soluble solids: The maximum TSS (5.51°B) was observed in control after 9 days of storage which was followed by treatment Half ripe (5.43°B) Minimum TSS (3.55°B) was found in immature green tomatoes, which was followed by mature green tomatoes (4.22^{0}B) among all the treatments. It may be due to conversion of starch into sugar in ripening process. The TSS content of tomato gradually increased during the storage period.

Effect on total carotenoids: The total carotenoids (mg/100g) increased rapidly up to 9 days of storage in all the treatments. The maximum total carotenoids was observed in ripe fruits as early as 9 days after storage (26.28mg/100g) which was followed by in half ripe (17.09mg/100g) and minimum was found in immature green tomatoes (6.75/100g) after 9 days of storage.

Effect on ascorbic acid: The ascorbic acid decreased significantly up to 9 days of storage for all the treatments, but the maximum ascorbic acid was observed in immature green tomatoes (14.17mg/100g) initially and the minimum was found in ripe tomatoes after 9 days of storage. The fruits during storage, in general showed a declining trend in ascorbic acid content significantly irrespective of the treatments applied. A reduction in ascorbic acid content with the subsequent prolongation of storage might be due to rapid oxidation phenomenon of organic acid in later stage of storage (Orzolek and Aggel, 1974).

Effect on pulp recovery: The amount of pulp recovery from fruits at edible and marketable stage is shown in Table 1. The maximum percentage of pulp recovered was from the control fruits (76%) followed by half ripe tomatoes (64%). The breaker stage and mature green tomatoes also recovered pulp upto satisfactory level (63.04% and 63%, respectively). But the immature green tomatoes could not recollect even 50% of the juice at edible stage.

Table 1: Effect of maturity on pulp recovery of tomatoes at marketable stage

Treatment	Sample wt. (g)	Pulp wt. (g)	Pulp recovered (%)
Ripe/Control	2500	1900	76.00
Half Ripe	2500	1600	64.00
Breaker	2500	1576	63.04
Mature green	2500	1575	63.00
Immature green	2500	1215	48.60

The pulp recovery percentages of mature green and above stages of tomatoes were higher than the immature tomatoes. The other parameters like ripening percent, firmness were observed in better state in mature stage tomatoes. As the farmers apply ethephon in immature tomatoes, their nutritional quality is inferior to the tomatoes harvested after maturity.

23 BIOTECHNOLOGY

Protocol Development and Micro propagation

Standardization of protocol for advanced lines of strawberry and their large scale multiplication

The experiment was undertaken with a view to develop a suitable protocol for rapid multiplication of strawberry. Shoot tip explants of strawberry lines SB003, SB006, SB007 and Rajshahi were cultured on MS medium supplemented with different concentrations and combinations of BAP, Kn and GA_3. Shoot initiation started within 6-7 days after culture initiation in all strawberry lines.

In vitro regeneration of okra (*Abelmoschus esculentus* L. Moench.)

The experiment was conducted to develop an efficient plant regeneration protocol for future genetic transformation of okra. Cotyledons and hypocotyls of BARI Dherosh-1 were cultured on MS medium supplemented with different concentrations of plant growth regulators along with a control. The types of responses were different in various plant growth regulators. Shooting response was only observed from cotyledon explants where hypocotyls produced callus with roots. The highest percentage (62.5%) and number of shoots (6.0) per explants were found in T_2 media. The regenerated shoots were transferred in rooting media for further development.

Study of comparative regeneration efficiency of different potato varieties

The experiment was carried out to compare regeneration efficiency of different potato varieties and selection of suitable potato varieties for genetic transformation. Internode explants of two BARI released high yielding varieties (BARI Alu-40 and BARI Alu-41) were cultured to compare their regeneration efficiency. Five different concentrations of Zeatin Riboside in combination with GA_3 and IAA were used for regeneration of explants. Among the two varieties, the maximum responding variety was BARI Alu-41 and the best treatment combination was T_3 regarding shoot number, node number and leaf number.

Standardization of protocol, *in vitro* production of BARI Kola-3 & BARI Kola-4 plantlets and their validation in hilly areas

The experiment was conducted to standardize protocol for *in vitro* production of BARI Kola-3 and BARI Kola-4 and to validate the performance of tissue cultured banana plantlets in hilly areas. Shoot tip was cultured on MS medium supplemented with different concentrations of BAP and 2ip for multiple shoot production. ½ MS medium supplemented with different concentrations of IBA was used for rooting. After successful plantlets production, 50 validation trials were established at eight upazillas of Khagrachari and Rangamati hill districts to validate the plantlets at hill valleys, slope and hill top. Yield and yield contributing characters have been analyzed to achieve the objectives. MS medium supplemented with 4 mg/l BAP was found suitable for *in vitro* production of multiple shoots in BARI Kola-3, where 5 mg/l BAP was found suitable in BARI Kola-4. Both of the varieties produced well developed roots in ½MS medium supplemented with 0.5 mg/l IBA. BARI Kola-4 showed the better performance compare to BARI Kola- 3 for *in vitro* propagation. Hill valleys are suitable for tissue cultured banana production followed by hill base where are minimum irrigation facilities were available. Due to water scarcity at hilly areas, hill tops and slopes were not suitable for tissue cultured banana cultivation. It should be kept confined on the base of the hills and valleys. March-April plantation was suitable for banana cultivation at hilly areas. Market price of BARI Kola-3 was higher than the BARI Kola-4 and farmers were interested to cultivate BARI Kola-3. Quick growing vegetables like lalshak, radish, pumpkin, tomato, cotton, bush bean etc. were suitable for intercrop in the tissue cultured banana field during the vegetative growth stage.

Rescue of amritsagar banana from extinction through biotechnological approaches

The experiment was undertaken with a view to collect and *in vitro* propagation of Amritsagar banana variety and to prevent the extinction of Amritsagar banana variety and reintroduce its cultivation at farmer's level. Amritsagar banana collected from Goforgaon & Kapasia were compared with each other by following the standard Descriptor for Banana (*Musa* spp.). These comparisons demonstrate that Amritsagar banana (Goforgaon) was superior to Amritsagar banana (Kapasia) in respect of fruit length, diameter, weight and total fruit number. Shoot tips of Amritsagar banana (Goforgaon & Kapasia) were cultured on MS medium supplemented with different concentrations of BAP and IBA. Five different concentrations of BAP and IBA were used in this study. Well developed shoots were transferred into ½ MS medium supplemented with different conc. of IBA for root induction. Five different treatments were tested and maximum numbers of longest roots were observed in both lines in treatment $T_{3.}$ The plantlets were transferred into the poly bag containing soil and cowdung.

***In vitro* regeneration of chickpea (C*icer arietinum* L.)**

The experiment was conducted to develop an efficient regeneration protocol of chickpea and to use the developed regeneration system for future genetic transformation work. Mature embryo and cotyledon pieces of BARI Chola 7 were used for *in vitro* regeneration. Seven different concentrations of 2, 4-D were used for callus formation and shoot development. The highest percent of explant (100%) produced callus in T_1 to T_5 treatments from isolated mature embryo explant. In case of cotyledon explant, 100% callus formation was observed in all the treatments except T_4 treatment. In shoot regeneration T_3 performed better.

Development of an efficient regeneration system of banana

The experiment was carried out to develop an effective regeneration protocol of banana for future transformation work. Flower buds, apical dome and rhizome sections were used as explant for callus induction. Explants were cultured on MS medium supplemented with different concentrations of 2,4-D singly and in combination with different concentrations of IAA and NAA. The highest percentage of explant produced callus in T_1 and T_2 treatment (100%) compared to other treatments in male flower bud explant. In apical dome sections, T_1 treatment showed the maximum callus (100%) while in rhizome sections, T_3 treatment showed the maximum callus (88%).

Development of *in vitro* regeneration technique for gerbera

The experiment was conducted to develop a reproducible method for rapid micropropagation and to see the adaptation at green house and nursery condition. Shoot tip, immature ovule, leaf and petiole have been cultured on MS (Murashige and Skoog, 1962) medium supplemented with different concentrations of BA, TDZ, IAA and $GA_{3.}$ Immature ovules produced embryogenic callus and plantlets on MS medium supplemented with BAP 3.5 mg/l + IAA 0.5 + GA_3 0.1 mg/l. Mother stock was developed for continuation of this study.

Production of wheat double haploids through wheat x maize crossing

The experiment was undertaken with a view to develop immediate homozygosity of segregated lines, to reduce breeding time for variety release and to improve efficiency in screening for resistance. Two F_1 hybrids of bread wheat were crossed with maize pollen. Out of 421 pollinated florets from two F_1

hybrids of wheat, 340 green parthenocarpic caryopsis (GPC's) were obtained which was 80.76% of total pollinated florets. A total of 70 embryos (20.59% of GPC's) were rescued and 35 of them (50% of total embryos) germinated. Ten haploid (14.29% of total embryos) green plants regenerated from the germinated embryos. Regenerated haploid plants were treated with colchicine and eight plants survived. The results demonstrated the possibility of this method to produce homozygous wheat genotypes in short time by doubling of haploid lines generated through pollination of wheat F_1 plants with maize pollens.

Molecular Genetics and Genetic Engineering

PCR-based detection and characterization 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. Sequence data of the complete 'A' genome of 32 isolates has been submitted to NCBI database. Phylogenetic analysis was carried out 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. Samples of several other plants including okra were collected and DNA was extracted for further analysis.

Transformation of tomato for broad spectrum resistance against leaf curl viruses

The experiment was carried out to construct appropriate plasmid vectors for virus derived resistance against ToLCV and transformation of tomato plants with vectors harbouring cloned virus sequences. Based on the genome sequence of various ToLCV strains, specific primers were designed for amplification of the DNA fragments from the various ToLCV strains sequenced earlier. Several DNA fragments were amplified from different strains and cloned. Two plasmid vectors were constructed for transformation work. Early evidence of shoot regeneration was observed from transformed tomato explants.

Development of an efficient genetic transformation system for eggplant (*Solanum melongena* L.)

The experiment was conducted to develop an efficient genetic transformation protocol for locally adapted eggplant varieties. Hypocotyls of EG-203 were cultured on different concentrations of auxins and cytokinins for regeneration. Based on the regeneration efficiency transformation was carried out using a binary plasmid containing the kanamycin resistant selectable marker gene and the GUS reporter gene. Explants were co-cultivated with *Agrobacterium* cells and cultured on selection medium. One hundred and twenty explants were cultured in each treatment and showed different survival percentage.

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_1 and BC_2 generations, respectively. Seeds from BC_3 were harvested and kept for further analysis. Plants having good bread making quality were also identified among the selected plants using specific PCR markers.

Molecular and biochemical characterization of Bangladeshi wheat varieties for bread making quality

The experiment was conducted with a view to characterize 26 wheat varieties for bread making quality through Polymerase Chain Reaction (PCR) method using gene-specific markers for 7 High Molecular Weight Glutenin Subunit (HMW-GS). These varieties were previously characterized through Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE) method. Ax2*, Ax1, Dx5, Bx7, BxFp, ZSBy8F5/R5, ZSBy9Af1/R3 gene specific markers were used to identify Glu-Ax2*, Glu-Ax1, Glu-Dx5, Glu-Bx7, Glu-Bx17, Glu-By8 and Glu-By9 alleles respectively. For A1 locus 22 varieties were found containing Glu-Ax2* allele whereas, rest of the four varieties containing Glu-Ax1 allele. In Glu-D1 locus, 16 varieties were identified containing Dx5+Dy10 allele. For Glu-B1 locus, 5 varieties were found with Bx17 allele. Bx7 allele was usually associated with either of two subunits, By8 or By9. Twenty two varieties were found with Bx7 allele however no PCR amplifications were found for By8 and By9.

Assessment of stress-tolerance attributes in wheat using gene-specific molecular markers

The experiment was conducted for heat shock protein based SNP marker for terminal heat stress in twenty two local and two Australian wheat varieties. Attempts were made to identify single nucleotide polymorphism (SNP) and to differentiate the heat tolerant and heat susceptible genotypes of wheat using heat shock protein (HSP16.9) as the target gene. DNA fragment covering a partial sequence of Triticum aestivum L. HSP 16.9, were amplified and allele specific primers based on the SNP were used to screen the heat tolerant and susceptible genotypes. Results obtained from this HSP derived SNP marker associated with terminal heat stress in wheat could be used by the breeders for improving tolerance to high temperatures in wheat breeding programmes.

Identification of nuclear and zygotic seedlings of sweet orange using molecular marker

The experiment was undertaken for selection of nuclear seedling's plant for true to type and zygotic seedlings for F_1 hybrid and regeneration frequency of nuclear seedling and zygotic seedlings. PCR based detection was done on twenty seven plantlets (BARI Malta-1) to identify zygotic or nuclear seedlings using 19 SSR primers. A total of 11 SSR primers was found effective to the individual identification. The Primer 02 (5'-AGAGAAGAAACATTTGCGGAGC) and 06 (5'-AAAGGGAAAGCCCTAATCTCA) were found to be more effective than other primers at distinguishing zygotic individuals. Seedlings with the same banding patterns as the mother plants were identified as nuclear seedlings.

Development of disease resistant, LEA (low erucic acid) quality BARI Sarisha-14 through marker-assisted backcrossing

The experiment was conducted to isolate the low erucic acid rapeseed plants from Bangladesh cultivars through marker assisted selection. To develop low erucic acid mustard cultivars, high erucic acid (HEA) mustard cultivars were interspecifically crossed as recurrent parents to a canola quality rapeseed. In the advance backcross homozygous e1e1 type lines were developed through marker assisted selection. Fatty acid composition in seeds revealed very low erucic (0.3 - 0.8%), high oleic (53.0 - 67.9%), and moderate linoleic (9.7-17.8%) acid contents, which belonged to the zero erucic acid class. Developed lines also contained *Fusarium* wilt resistant loci as well as short duration quality. Others yield contributing characters also found satisfactory in some advance lines compare to cultivated short duration *Brasica rapa*, BARI Sarisha-14. So, promising lines would contribute to *Fusarium* resistant, Low erucic acid (LEA) quality short duration rapeseed breeding.

Adaptation/on-farm trials

Validation trial of tissue cultured plantlets of BARI Malta-1

The experiment was carried out to see the growth and development of malta plantlets raised from nuclear seedlings and to evaluate the field performance of tissue cultural malta plants compare to grafted one. Tissue cultured and grafted saplings of BARI Malta-1 have been planted to see the field performance at ARS, Ramgarh and ARS, Raikhali. Both of tissue cultured and grafted plants of BARI Malta-1 produced fruits in third year. Highest no. of fruits/plant (35.7) was found in tissue cultured plant followed by grafted one (6.5) in ARS, Ramgarh. Maximum plant height (219 cm), no. of brunches (8.50) and base girth (17.20 cm) was found in tissue cultured plants. Grafted plants produced 192 cm plant height along with 8.75 cm base girth and 6.4 branches. Vigorous growth and development was observed in tissue cultured plants compare to grafted ones during third year (Tissue culture: N-S = 162.75 cm, E-W = 149 cm; grafted: N-S = 143.25 cm, E-W = 141 cm). In case of ARS, Raikhali, maximum plant height (243 cm), no. of brunches (10.0) and base girth (22.42 cm) was found in tissue cultured plants in third year. Highest plant canopy N-S= 292 and E-W= 292.5 cm was found in grafted plants where tissue culture plants had N-S= 298.17 cm and E-W= 297.14 cm (Table 2). However, vigorous growth and development was found in tissue cultured plants compare to grafted ones. Both of tissue cultured and grafted plants produced flowers and fruits after three years of planting.

Validation trial of tissue cultured plantlets of jackfruit

The experiment was conducted to see the growth and development of tissue cultured jackfruit plantlets and to evaluate the yield of tissue cultured Jackfruit plants compared to seeded one. Tissue cultured, seeded and grafted saplings of Jackfruit were planted to see the field performance on growth and yield. Highest plant height was found in Tissue cultured plants (5.56 m) followed by seeded (3.92 m) and grafted (3.90 m). Highest base girth (29.3 cm) was also recorded in tissue cultured plants followed by grafted BARI Kathal-2 (21.15 cm). Also, highest number of branch/plant was recorded in tissue cultured plants followed by grafted where lowest was in seeded plant. Maximum plant canopy was recorded also in tissue cultured plants followed by grafted and seeded plants both in North-South & East-West direction. There was no male or female flower in any of tissue cultured, grafted and seeded plants up to third year. But all of the tissue cultured and grafted plants produced male flower where one seeded plant produced fruits in fourth year.

ABSP-II Research activities

Generation advancement of rest Bt. brinjal lines

The experiment was conducted to develop the new Bt. brinjal varieties. Five Bt. Brinjal lines viz. Bt. Dohazari, Bt. Shinghnath, Bt. Khatkhatia, Bt. Islampuri and Bt. Chega were tested along with its counterpart non-Bt. varieties. Considering the distinctiveness, uniformity and stability of the lines, Bt. Dohazari might be proposed to release as GE crop. Slight variation was observed in Bt. Shinghnath and Bt. Khatkhatia. Under close observation, it might be released as GE crops as soon as possible. More purification needed in case of Bt. Islampuri and Bt. Chega.

Breeder seed production of Bt. brinjal varieties in Gazipur

The experiment was carried out with a view to produce seeds of newly released Bt. brinjal varieties. 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 the Biotechnology Research Farm, BARI Gazipur during the winter season of 2014-15. The total plot size for each variety was 398 m^2. The amount of seed harvested as 0.8, 3.5, 2.0 and 0.45 kg from BARI Bt. Begun 1, BARI Bt. Begun 2, BARI Bt. Begun 3 and BARI Bt. Begun 4, respectively.

Breeder seed production of BARI Bt. Begun -1 in Rangpur

The experiment was conducted with a view to produce seeds of newly released Bt. brinjal varieties. The cultivated area was 1225 m^2 containing 2296 individual brinjal plants. Each of the plant was tested whether it was Bt. positive or Bt. negative. Only Bt. positive plants were kept in the field, from where 52 kg seed was harvested.

Breeder seed production of BARI Bt. Begun -2 in Barisal

The experiment was undertaken with a view to produce seeds of newly released Bt. brinjal varieties. The experiment was conducted during the winter season of 2014-15. The total plot size was 1500 m^2. The amount of seed harvested was 25kg.

Breeder seed production of BARI Bt. Begun-3 in Jamalpur

The experiment was conducted with a view to produce seeds of newly released Bt. brinjal varieties. The cultivated area was 765 m^2 containing 715 individual BARI Bt. Begun-3 (Nayantara) plants. Each of the plant was tested whether it was Bt. gene positive or Bt. gene negative. Only Bt. gene positive plants were kept in the field, from where 2.5 kg seed was harvested.

Breeder seed production of BARI Bt. Begun-4 in Pabna

The experiment was undertaken with a view to produce seeds of newly released Bt. brinjal varieties. A land of 1200 sq. m area was prepared by ploughing and laddering. Fertilizer application and other intercultural operations were done as per recommendation of Bt. Begun production technology booklet. Seedlings at the age of 40 days were transplanted on November 18, 2014 with a spacing of (1m x 1m). Post planting flood irrigation was provided for well establishment of the seedlings. Transplanted seedlings were established successfully and gave a good plant stand. About fifty per cent plants were destroyed which looks dissimilar to the originality of the variety, to maintain purity of the breeder seed. Uniform and well ripped mature fruits were collected and dissected then soaked into water in plastic drum. Seeds were extracted from the fruits and washed it in water to remove fleshes and other dirt's. Clean fresh seeds were well dried in the sun, then cooled in the room temperature. Dried seeds were packed in air tight poly bag with cloth bag and stored in deep freeze. A total of 4.5 kg seeds were produced and stored.

Quantification of Cry1Ac protein in newly released four Bt. brinjal varieties

The experiment was conducted to quantify the Cry1Ac protein in newly released four Bt. brinjal varieties. Bt. brinjal, a transgenic brinjal created by inserting a crystal protein gene Cry1Ac from the soil bacterium *Bacillus thuringiensis*. Four Bt. varieties - BARI Bt. Begun 1, BARI Bt. Begun 2, BARI Bt. Begun 3 and BARI Bt. Begun 4 are started to cultivate in Bangladesh in 2014 as first genetically engineered crop in the country. In the present study, ELISA technique was adopted to quantify the Cry1Ac proteins in newly released four Bt. brinjal varieties. The Cry1Ac expression was found to be variable among the varieties and varied from 29.53 to 33.99 $\mu g\ g^{-1}$.

Regulatory trial of transgenic late blight potato clones under confined field condition

The experiment was carried out to evaluate gene equivalency between transgenic and non transgenic potato. This trial was conducted at six locations (Gazipur, Bogra, Jessore, Rangpur, Comilla and Chittagong of Bangladesh Agricultural Research Institute) with six transgenic RB hybrid clones of potato. The clones were: D-951 (2), D-951 (3), D-951 (12), D-951 (13), D-951 (137) and D-951 (304). Non-transgenic BARI Alu-7 (Diamant)) was used as check. Seed tubers were planted during December 2 to 8, 2014. The experiment plot was laid out in RCB design with three replications. As this year trial was regulatory perspective, so non transgenic Diamant (check) was sprayed alternating with fungicides Secure (0.1%) and Dithane M-45 (0.2%) from initiation of late blight to keep it free from the disease. Incidence of late blight appeared with different degree became well pronounced in five locations (Gazipur, Bogra, Jessore, Comilla, Rangpur, and Comilla) out of six locations.There was no late blight infection at Hathazari, Chittagong. Initiation of disease symptom detected at 35 to 70 days of plant age in border crop Diamant where no fungicide was applied. In each location non transgenic border crop Diamant was damaged 100% while hybrid clones performed well to late blight having distinguishable lower AUDPC value. AUDPC value was less than 100 in all five locations except Bogra. Many insect pests and beneficial insects (aphid, ladybird beetle, cut worm, whitefly etc.) visited in all RB hybrid clones along with the check variey, indicating RB hybrid clones had no harmful effect on insects. PLRV, PVY and PVX was present sporadically, this might be caused secondary infection. Bacterial wilt, soft rot, stem canker, dry rot was present irregularly in different locations over the Bangladesh. Common scab was present in all the hybrid clones as well as check, Diamant. Morphological and tuber characteristics were almost similar in both transgenic clones and non transgenic Diamant. Regarding yield, it varied to some extent over locations in both transgenic clones and non transgenic Diamant.

Detection of RB gene in selected transgenic late blight resistant potato clones through PCR

The experiment was conducted to find out the RB gene integration in selected LBR potato clones. Six selected transgenic late blight resistant potato clones were used to find out the RB gene integration. DNA was extracted from 6 potato clones along with non transgenic control variety Diamant. Through PCR method RB gene confirmation test was done. Among the 6 LBR potato clones, all showed positive band which indicates that RB gene was present of those clones.

24 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 part 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 ভাণ্ডার"** 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 238 information have been uploaded on the website during 2014-15.

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 154 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 2014-15.

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 546 network and antivirus related maintenance work have been done during 2014-15.

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).

Human resource development

ASICT division has engaged human resources development through various type of training program related to ICT. ASICT division has been conducted five training program namely Training course on Data Analysis of Experimental Design using open source R (Four batches) and Training course on Agricultural Research Data Analysis using SAS (One batch) during 2014-15.

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 19 maps for different centres/divisions based on their requirements.

Participation of ICT fair

However besides services ASICT division has been participated ‘District Digital Innovation & Science Fair’ held on 27-29 January 2015 @ Rajbari, Gazipur; Digital World-2015 held on 9-12 February 2015 @ Bangabondhu International conference Center. Dhaka; National Agro-Technological Fair held on 5-7 April 2015 @ Department of Agriculture Extension, Farmgate, Dhaka and Agro-Technological Fair held on 15-17 April 2015 @ Kapasia Upazilla Campus, Gazipur.

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 2014-15.

25 Training, Communication, Publication Library and Photography Activities

Training

During 2014-2015, Three scientists were sent for Post Doctorate, Nine scientists were sent for Ph.D., Four for M.S./M.Sc. Three hundred fifty nine scientists/officers were sent abroad for training/workshop/study tour/seminar, etc. Moreover, a good number of scientists were sent to different Universities in the country for Ph. D. and MS degree.

Communication

Seminar

A total of 14 (Fourteen) seminar were organized at BARI during 2014-15 covering the area of Agronomy, Entomology, Horticulture, Soil Science, Plant Physiology, Information & Communication Technology & Postharvest Technology. Among these, four seminar on Agronomy, one on Horticulture, one on Entomology, one on Soil Science, one on Plant Physiology, one on Information & Communication Technology, one on Postharvest Technology. Four seminar on plant Breeding division were organized by T&C wing, BARI.

MoU & LoA signed

During the period of 2014-15, BARI had signed MoU with 11 (eleven) organizations, LoA with 2 (two) organizations and Modification Agreement with 1(one) organization. Among the organizations signed MoUs, four were seed companies, one was public university and six were voluntary organizations. The purpose of MoU and LoA were to promote collaboration between BARI and the concerned organization to enhance 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 journal, 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 received from scientists of home and abroad have been processed for publication in the journal.

Library

2. Information Resources added during the year 2014-2015:

a. **Books, Reports, Proceedings etc. and Thesis: 411**

Items	Purchased	Exchange	Gift /Complimentary	Total
Books	138	37	48	223
Research reports, project reports & proceedings	-	53	106	159
Thesis (MS & Ph.D.)	-	-	29	29

b. Serial Publications (printed form)

	Titles	Issues
Journals:	***32***	***98***
Newsletters, bulletins etc:	**26**	**85**
	58	**183**

Items	Purchase	Exchange	Gift /Complimentary	Total
Journals:	Titles/issues	Titles/issues	Titles/issues	Titles/issues
Foreign	00/00	11/26	05/29	16/55
Local	02/04	08/10	06/29	16/43
Newsletters:		Titles/issues	Titles/issues	Titles/issues
Foreign		04/11	03/17	07/28
Local		02/02	14/50	16/52
Bulletins:		Titles/issues	Titles/issues	Titles/issues
Foreign		01/01	01/03	02/04
Local		-	01/01	01/01

3. Document Processed for Services:

SI. No.	Procured material processed	No.
01	**Document Accessioned**	411
02	Catalogued & Classified and pasted with call numbers, book pockets and due slips	411

4. Services Provided to the Scientists:

Sl. No.	Services provided to the Scientists	Number
1.	Article downloaded from Online journal (Feb 2015)	5388
2.	Documents Charged/Discharges	538
3.	Users Referenced	1190
4.	Internet Services to the Scientists & Students	240
5.	Number of photocopies made	9384
6.	Publication Distributed (Books, reports & journals) in Exchange & Complimentary)	312
7.	Correspondence made	247

Photography

Activities of Photography Section during 2014-2015

SI. No	Activities	Number
1	Photograph exposed in digital camera	41,000 above
2	Photo editing	28,500 above
3	Video Recording program	121
4	Make DVD, CD	1000 above

26 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. 8030.90 lakh. The GoB funding was Tk. 6080.98 lakh, which was offered by different aid-giving agencies as Project Aid (PA)

Besides, an amount Tk. 16700.23 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 2014-2015 (in lakh Tk.)

Total	**GOB Head**			**Project Aid (PA/RPA**	**Capital Head**	**Revenue Head**		**Total**
	ADP	**Revenue**	Total			**ADP**	**Revenue**	
24731.13	**6080.98**	**16700.23**	**22781.21**	**1949.92**	**3999.00**	**4031.90**	**16700.23**	**20732.13**

Table-2: Development Budget (Annual Development Program) of BARI for 2014-2015 (in lakh Tk.)

Name of Projects	**Total**	**GOB**	**PA**	**Capital**	**Revenue**		**Total**
					Pay & Allow.	**Contingency**	
Integrated Quality Horticulture Development Project (Phase II) (BARI Part)	1240.00	1240.00	0	240.00	5.00	995.00	1000.00
Farm Machinery Technology Development and Dissemination (BARI Part)	240.98	240.98	0	74.00	42.67	124.31	166.98
Tuber Crops Development Project (BARI Part)	329.00	329.00	0	54.00	0	275.00	275.00
Enhancing Quality Seed Supply	1865.00	350.00	1515.00	1375.00	11.89	478.11	490.00
Mujibnagar Integrated Agricultural Development Project	150.0	150.00	0	0	7.58	142.42	150.00
Continuation and Expansion of Pesticide Research in Pesticide Analytical Laboratory at BARI	145.00	145.00	0	65.00	3.55	76.45	80.00
Integrated Agricultural Productivity Project (BARI Part)	439.92	5.00	434.92	5.00	71.80	363.12	434.92

Name of Projects	Total	GOB	PA	Capital	Revenue		Total
					Pay & Allow.	Contingency	
Development and expansion of research and research infrastructure of BARI	3200.00	3200.00	0	2000.00	0	1200.00	1200.00
Pirojpur-Gopalgonj-Bagherhat Integrated Agricultural Development Project (BARI Part)	121.00	121.00	0	11.00	4.17	105.83	110.00
Citrus Development Project (BARI Part)	300.00	300.00	0	175.00	13.00	112.00	125.00
Total :	**8030.90**	**6080.98**	**1949.92**	**3999.00**	**159.66**	**3872.24**	**4031.90**

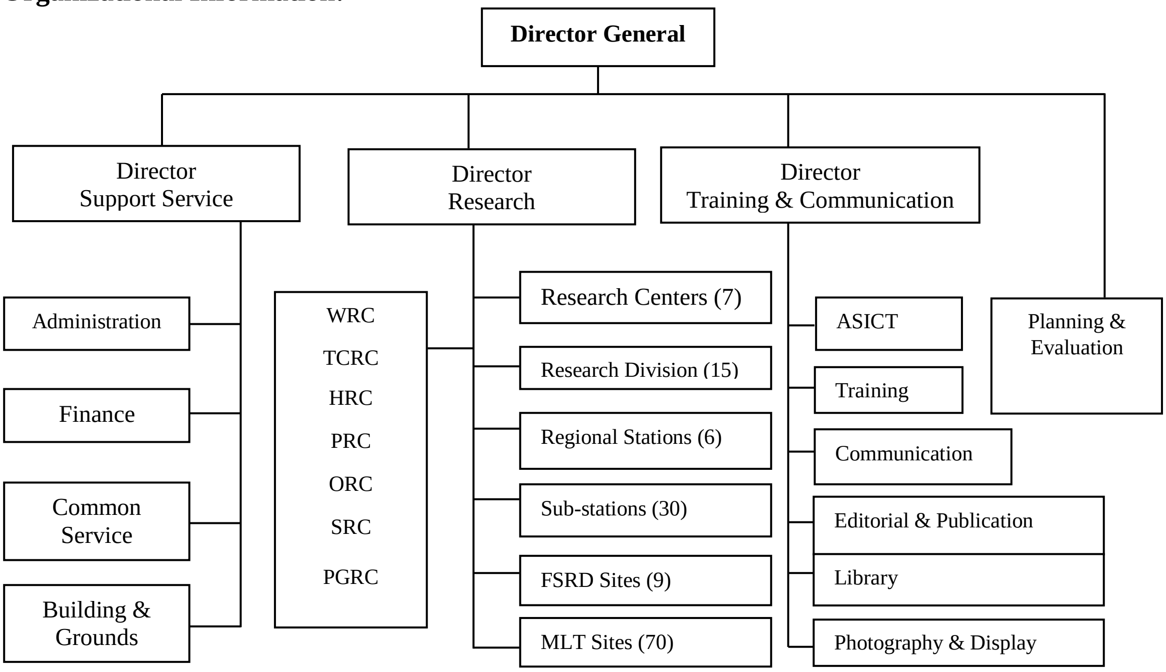
27 INFORMATION REPORT
(as per Information Commission Requirements)

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, 6 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
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
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

Appellate Officer	
Officer’s Name	Dr. Md. Rafiqul Islam Mondal
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 2014

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 পরিমান	কর্তৃপক্ষ কর্তৃক গৃহীত বিভিন্ন কার্যক্রমের বিবরণ
১৫৬ *২টি (তথ্য কমিশনের ফরমেট অনুযায়ী) *১৫৪টি (বিএআরআই এর ওয়েব সাইট এবং মোবাইল অ্যাপস হতে প্রাপ্ত ই-কৃষি সংক্রান্ত তথ্যের প্রশ্ন সংখ্যা)	১৫৬ *২টি (তথ্য কমিশনকে জানানো হয়েছে) *১৫৪টি (বিএআরআই এর ওয়েব সাইট, মোবাইল অ্যাপস, এসএমএস এবং ই-মেইল এর মাধ্যমে সরবরাহকৃত ই- কৃষি সংক্রান্ত তথ্যের উত্তর সংখ্যা)	-	-	-	-	-	-

Bangladesh Agricultural Research Institute

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