BRRI Annual Report Summary 2010-11

Program Area: Varietal Development
Plant Breeding Division

A total of 484 crosses were made and 333 were confirmed. Totally 5,651 progenies were selected from F_2 populations. From segregating generations 19,094 plants and 953 fixed lines were selected. Four hundred thirty-five advanced lines were selected from observational and yield trials. A total of 100 germplasm from ten nursery sets of INGER were selected for using in the breeding programme.

NSB approved the recommendation of technical committee to release IR73678-6-9-B (AS996) as BRRI dhan55 for Boro and T. Aus season; IR74371-70-1-1 and BR7873-5*(Nils)-51-HR6 as BRRI dhan56 and BRRI dhan57 for T. Aman season. In farmers field condition BRRI dhan55 yielded 7.3 t/ha with growth duration of 145 days in Boro season, while in T. Aus, it produced 5 t/ha grain yield with 105 days life span. It is photo-insensitive and can tolerate moderate salinity, drought and cold. NSB also approved the recommendation of technical committee to release IR74371-70-1-1 and BR7873-5*(Nils)-51-HR6 as BRRI dhan56 and BRRI dhan57 for T. Aman season. BRRI dhan56 and BRRI dhan57 can tolerate drought at reproductive stage. In farmers' field, BRRI dhan56 and BRRI dhan57 yielded 4.2 and 4 t/ha respectively, which were almost similar to that of BINA dhan7. However, the former matured five days earlier and the latter matured 10 days earlier than BINA dhan7. BRRI dhan56 can tolerate 10-12 days drought spell at reproductive stage without yield reduction, while BRRI dhan57 can escape drought due to its shorter growth duration. At 70-80 cm perch water table depth below the surface level and soil moisture content below 20%, BRRI dhan56 and BRRI dhan57 can produced 3.5 and 3 t/ha grain yield respectively. Field evaluations of BRRI dhan29-SC3-28-16-4-HR2 has been completed in PVT trials at eight locations of Bangladesh by BRRI internal team during Boro 2010-11. BRRI dhan29-SC3-28-16-4-HR2 showed grain yield similar to that of BRRI dhan29 but it matured one week earlier. Field evaluations of IR72579-B-3-2-3-3 and BR7105-4R-2 have been completed during Boro 2010-11 in PVT trials at six locations of coastal saline areas of Bangladesh. BR7105-4R-2 yielded almost similar to BRRI dhan47 with the same growth duration but 1.7 t/ha higher than BRRI dhan28. This line is also non-shattering type. This genotype can tolerate 7-8 dS/m salinity throughout its growing period. On the other hand, IR72579-B-3-2-3-3 produced 0.4 t/ha yield advantage over BRRI dhan28, though it yielded lower than BRRI dhan47. This genotype can tolerate 8-10 dS/m salinity throughout its growing period. These two genotypes are under process of variety release system as salt tolerant variety for Boro season. Field evaluations of BR7323-4B-1 and BW328 have been completed during Boro 2010-11 in PVT trials at seven locations of Bangladesh. BR7323-4B-1 yielded 0.8 t/ha and BW328 yielded 0.6 t/ha higher than BRRI dhan28 but none of them exceeded BRRI dhan29. However, both the lines matured one week later than BRRI dhan28.

Under breeding for submergence tolerance programme, participatory variety selection functions were arranged in three mother trials (One in natural flash flood, one in controlled submergence and another in rainfed condition). Considering total votes over flooded and non-flooded condition, the genotype IR85260-66-1192(51) secured the highest votes and BRRI dhan52 (33) got the lowest votes. In salinity programme, PVS trials were conducted at seven different locations of Pirojpur, Khulna, Satkhira, Noakhali and Feni districts in T. Aman season. Three lines viz IR72049-B-R-22-3-1-1(40) OMCS2000 (36) and IR77092-B-2R-B-48(28) including BRRI dhan53 (66) and BRRI dhan54 (47) were chosen by farmers in T. Aman season. These three lines were 8-21 days earlier than BRRI dhan53, BRRI dhan54 but produced 0.6-1.7 t/ha less yield than them. The water salinity was varied from 0.1 to 9 dS/m. The yield performance of BRRI dhan54 was found as the best followed by IR77092-B-2R-B-48 and BR7216-2B-26-2. Under the drought breeding programme, PVS trials were conducted in Nachole, Chapai Nawabganj; Gomastapur, Chapai Nawabganj, Godagari, Rajshahi, Kushtia sadar and Magura sadar. The genotypes

IR83377-B-B-93-3, IR83381-B-B-6-1 and IRRI 123 secured 1st, 2nd and 3rd position with respect to the total votes casted by the farmers.

Hybrid Rice Component

During T. Aman season 2010, 71 test crosses and 90 A × R crosses were made from source nursery. Seventy-seven test crosses (F_1s) were evaluated for their pollen fertility status of which nine entries have been shown complete sterile and they were immediately backcrossed with their corresponding male parents for conversion. Thirteen BC_6 generations were designated as new CMS lines and included into CMS maintenance and evaluation nursery. Seventy-six CMS lines were maintained by hand crossing for seed increasing and genetic purity. Sixty test crosses and 163 A × R crosses were made using eight CMS lines during Boro season 2010-11 from source nursery. A total of 106 test crosses (F_1s) were evaluated for their pollen fertility status under test cross nursery of which two entries have been shown complete sterile and they were immediately back crossed with their corresponding male parents for conversion. Out of 37 BC_5 generations 35 were found stable in pollen sterility and other desirable agronomic characteristics and advanced as BC_6 generation. Ninety one CMS lines along with their respective maintainer lines were maintained by hand crossing. Under development of short duration hybrid programme 16 test crosses were made in T. Aman 2010 and evaluated in Boro 2011 and out of them six were found sterile. Seventeen test crosses were made for searching prospective maintainer and restorer from NPT advanced lines. To develop BB resistance hybrid variety, five test crosses and six inbred crosses were made.

Biotechnology Division

The objectives of the Biotechnology Division include molecular characterization of important rice genotypes, development of modern rice varieties through different biotechnological techniques and carry out basic or upstream research pertinent and applicable to the development of improved variety. During the reporting period the division conducted eight experiments under three projects. Two backcrosses (BC_3F_1 and BC_4F_1) were made for pyramiding bacterial blight resistance genes (x*a13* and *Xa21*). From the gene pyramiding experiment, 90 and 290 BC_4F_1 seeds were harvested from BRRI dhan28*4/IRBB60 and BRRI dhan29*4/IRBB60 respectively. In yield enhancement QTLs programme, out of 430 SSR markers screened, 102, 108, and 89 primers were found polymorphic for BRRI dhan28/*Oryza rufipogon (Acc. no. 103404)*, BRRI dhan28/*Oryza rufipogon (Acc. no. 105890)* and BRRI dhan29/*O.rufipogon (Acc. no. 103404)* respectively. On the other hand, 220 SSR markers were screened for polymorphic survey in salinity QTLs identification programme and among them, 50 markers were found polymorphic. Sixty-seven BC_3F_1 plants were generated for introgression of *sub1* gene into BRRI dhan44. A total of 423 primers were surveyed for BRRI dhan44 and BRRI dhan52 and among them 77 primers gave polymorphic bands. A total of 437 plants were selected and 22 apparently homozygous lines were bulked from tissue culture derived materials. Twenty-two apparently superior genotypes were selected for further evaluation.

Genetic Resources and Seed Division

Three hundred twenty-five germplasms, of which 65 Aus, 209 Aman and 51 Boro rice, were collected from different districts including hilly areas. A total of 337 germplasms were characterized with 45 morpho-agronomic characters during Aus, T. Aman and Boro seasons. Besides, 1956 germplasm accessions including 182 new collections in T. Aman and Boro were rejuvenated during the reporting year. Apart from this, 55 new collections were registered as accession. Genebank database preparation is going on and about 200 accessions have been entered into the database with available information during the reporting year. Genetic diversity was pronounced in 40 T. Aman rice germplasm and the varieties were grouped into six clusters. Among the tested varieties/line Burikatari, Bolorum, Chakulia, Shada Dumra and Kola Dama have allelopathic potentials and more inhibitory character to suppress weeds in

laboratory condition. Among the 36 rice germplasms tested, only one material Nizersail (DA-25) found to be resistant against bakanae disease.

Forty-eight BRRI developed and recommended varieties were maintained as nucleus stock. A total of 122.31 tons of breeder seed of which 35.38 tons from 24 varieties in T. Aman and 86.93 tons from nine varieties in Boro seasons were produced during 2010-11. About 27.60 tons of breeder seed from 18 varieties in T. Aman and 78.71 tons from 10 varieties in Boro and 0.83 tons from six varieties in Aus seasons were distributed. Around 2.23 tons truthfully labelled seeds (TLS) from 17 varieties of T. Aman and 11.83 tons truthfully labelled seeds from eight varieties of Boro were available for distribution. Around 2.15 tons seeds from 14 varieties of T. Aman and 11.78 tons seeds from eight varieties of Boro were distributed as quality seed (TLS) during the reporting year.

Two training programmes entitled "Breeder seed production and preservation techniques of rice" were organized under breeder seed project for the scientists and scientific assistant of BRRI. Eight training programmes entitled "Foundation seed production and preservation techniques of rice" were organized under STRASA, funded by Bill and Melinda Gates Foundation for SeedNet partners of stress prone areas. Three training programmes entitled "Importance and procedure of rice germplasm collection" were organized under CGP-KGF, project for the sub-assistant agricultural officers across the country.

Grain Quality and Nutrition Division

Three breeding lines were analyzed for physico chemical properties. The size and shape of grain were medium slender. Amylose content of these lines was in intermediate level. One line contains high protein level (9.0%). Cooking properties of these lines were not in desirable level.
The physico-chemical properties were determined for 21 local rice cultivars to differentiate superior quality variety. Most of the varieties contain high amylose. Among these cultivars, TR Aman, Depa, Bhoro chalam, Joal bagh had long grain, high protein and high amylose content that means these varieties can be considered as superior quality.

Partial results were presented at the aging effect of grain quality. Protein content of three varieties (BRRI dhan28, BRRI dhan29 and BRRI dhan50) increased a little after three months of storage. A significant increase was observed for amylose content. After three months storage, significant difference was found in cooking time and elongation ratio of these varieties.
The HYV variety, BR3 which grows in three seasons, was considered for the effect of different cropping seasons on chemical properties. Rice amylose content in Boro and Aus seasons is more or less similar (25.0-25.4%) whereas protein content was significantly higher in Aus season than Boro (8.1-8.9%).
Twenty local and modern varieties were analyzed for antioxidant properties. The HYV and aromatic rice varieties have high level of antioxidant properties which can be effectively utilized to mitigate daily requirement.

Program Area: Crop Soil Water Management

Agronomy Division

BRRI dhan46 could be grown as broadcasting of sprouted seed from 5-15 September @ 45-60 kg ha^{-1} and with the application of $N_{60}P_{12}K_{30}$ and $N_{80}P_{12}K_{30}$ fertilizers for satisfactory grain yield in late Aman situations. In Aman season IR74371-70-1-1 produced the highest grain yield (3.94 t ha^{-1}) on 25 July planting having growth duration 105 days. Urea spraying instead of urea top dress after full development of rice plant could save a portion of N fertilizer.

Integrated use of 2.5 tha^{-1} fresh or decomposed poultry litter and the rest amount of nutrient as STB fertilizer from chemical fertilizer could be practiced for a complementary better yield of rice.

The critical weed density in Aman season was nine weeds m^{-2} with 11.92 gm^{-2} dry matter accumulation. The critical weed density for *Scirpus maritimus* (Chesra) in Boro season was 18 weeds m^{-2} with 32.05 gm^{-2} dry matter accumulations. Among the tested varieties/lines Buri Katari(2), Bolorum, Chakulia, Shada Dumra and Kola Dama had allelopathic potentials and more inhibitory character to suppress weeds in laboratory condition. Application of 2.5 and 3.5 tha^{-1} FPL and the rest amount of nutrients as of STB from chemical fertilizers were the best option for higher grain yield in T. Aman and Boro seasons respectively.

Soil Science Division

The results of missing element experiment indicate that NPKSZn fertilization is required in Barisal, Satkhira and Sonagazi areas to obtain optimum rice yield, while in Rangpur farm soil needs only N application. In long term experiment at Gazipur, the reverse nutrient management indicates that if the soil is fertilized with optimum dose it may have the capability to produce similar yield as continuously fertilized soil.

Integrated nutrient management (INM) is a good option for obtaining higher rice yields either in double or triple rice cropping pattern. But it needs long term monitoring with respect to soil fertility evaluation. Carbon stock in lowland soil is higher than that of highland and medium highland soil. The rate of CO_2-C emission was higher in earlier stage of incubation irrespective of organic source both in flooded and moist conditions. However, rice straw emitted more CO_2-C than cow dung, poultry manure and rice root alone.

The application of waste concern organic fertilizer (WCOF) with IPNS based chemical fertilizer produced maximum rice yield. The use of WCOF may save a good amount of chemical fertilizer. On the other hand, addition of rice straw @ 4.5 t/ha (sun dry basis) in sandy-loam soils during Boro season increased rice yield remarkably as IPNS with chemical fertilizer.

Irrigation and Water Management Division

Among the four crop sequence, water productivity was maximum (12 kg/ha-mm) in T. Aman-Potato-Maize followed by 11.98 kg/ha-mm in T. Aman-Potato-Rice. But the maximum year round rice equivalent yield (24,329 kg/ha) and net return (Tk. 3,55,509) was recorded in T. Aman-Potato-Rice crop sequence. Therefore, T. Aman-Potato-Rice cropping pattern is the best for year round cropping plan under Gazipur condition. Aman varieties (short and long duration) suffered less drought and showed good yield performance if they are transplanted during 17 to 24 July. In T. Aman 2009, suitable dates of transplanting were 24 July and 31 July for short duration variety (BRRI dhan33) and 17 July and 24 July for long duration variety (BR11). In spite of losing yield due to drought, BR11 yielded higher than BRRI dhan33.

If we conserved water by levee management in T. Aman season, it may be used in land preparation, vegetative stage, and reproductive stage and ripening stage. Most of the time drought affects in the later part of Aman especially on reproductive and ripening stages of Aman rice. To avoid drought effect, seeding on 5 June and 15 June and transplanting on 15 July and 25 July could be suitable for short duration variety like BRRI dhan33. For long duration variety like BRRI dhan49 seeding on 5 June and 15 June and transplanting on 5 July and 15 July could be suitable to escape drought for Aman production.

In coastal area of Sonagazi, fresh groundwater bearing aquifer is identified at a depth from 155 m to 180 m, which can be used for crop production. By using this fresh water mono-crop area could be converted into a double or triple-crop area. These findings may be disseminated to other areas where similar condition exists. But long-term effects of groundwater extraction in coastal saline areas should be monitored. Rainwater harvesting in a reservoir could increase Rabi crops area in the coastal zone. Rainfed T. Aman -Tomato sequence is more profitable than the other cropping sequences. It is also evident that Rabi crop cultivation with pond water is profitable in the coastal saline area.

Groundwater level at BRRI farm, Gazipur is declining day by day and it is not fully recharged after the monsoon. In 2000 the maximum groundwater level was about 15 m from the ground surface which is

more than 27 m in 2011. So, the lowering of water table is about 12 m in 10 years, which is very alarming. The lowering of water table is due to increased pumping demand and scant rainfall from November to March.
AWD method is a proven technology for water and fuel cost in dry season (Boro). It saved about 23% to 24% water and increased yield benefit of Tk 2,651/ha for BRRI dhan28. DAE should demonstrate AWD technology in the intensive irrigated areas for reducing irrigation cost; increasing yield; and prevent the environmental degradation by reducing declining of groundwater table.

Plant Physiology Division

BRRI dhan55 is moderatlely tolerant to salinity. In contrast BRRI dhan28-*Saltol* introgressed with a *Saltol* QTL failed to prove its tolerance. Some genotypes, from different land race and other sources performing quite satisfactorily under drought conditions, are available for further exploitation for the nature of drought tolerance. IR77496-31-2-1-3-1 appears to be genotype tolerant to cold at the reproductive phase of the crop. The IR lines (IR62266-42-6-2) might have some tolerance too. However, further study is needed for confirmation. Either day or night water treatment (inundation with 3-4 cm of water) for 12 hours might have significant impact on growing healthy seedlings. Selection of cold tolerant (during reproductive phase) genotypes are in progress. Hybrid varieties showed their higher yield potential over modern inbred in Boro season only when it is transplanted earlier (from 20 December to 5 January). But for delayed transplanting recommended modern inbred varieties are better. Recommended modern inbred varieties are better for cultivation in Aus season compared to hybrids. Hybrid varieties Hera2, Aloron and Tia are very much sensitive to low temperature at their reproductive stage and at early transplanting it produced almost similar grain yield like inbred ones in Aman season. There is no difference between shattering percentage of rice grains between BRRI dhan47 and BINA8. The study of phonological development throughout the year to estimate the genetic coefficient is in progress. BRRI dhan48 and MS medium are to be recommended for callus induction, for regeneration 2.0 mgL^{-1} NAA and 2.0 mgL^{-1} Kn in MS medium are to be recommended.

Program Area: Pest Management

Entomology Division

The overall insect pest incidence was low in the reporting year. GLH, WLH and GH were the dominating pests. Higher incidence of insect pests was observed in the Aus and Aman seasons. The highest population of GLH was noticed in T. Aman rice fields amongst the habitats studied.
Among the natural enemies, SPD, LBB, damsel fly and CDB were dominant in different habitats in different seasons. SPD had the highest population in Aus and Aman season. LBB and STPD dominated the natural enemy population of seedbed and grass fallow of the Boro season.
The insect pest incidence was observed the highest at Rajshahi. GLH and YSB were the dominating pests at all the stations. Beside the normal two peaks of insect pests observed in April-May and October-November and additional peak of GLH in March was observed at Habiganj. The highest population of natural enemies was found at Barisal. The dominant natural enemies were GMB, LBB, CDB, STPD and SPD at different stations.
The necessary protocol required for the analysis of genomic DNA of GM was optimized. As the preserved samples of the different GM populations, collected from different GM endemic areas of the country, were damaged due to irregular power supply. The samples could not be analyzed for biotypes. The work will be accomplished in the coming year. A rearing technique of GM was developed.
The earth worm (or eel worm?) collected from Narail completed four generations in the soil of Kushtia, Narail and Gazipur and showed no adverse effect on rice plants. However, it needs further investigation.
The highest parasitism by T. zahiri on the RH egg was observed at the vegetative stage of T. Aman rice. Multiple parasitism was found common with T. zahiri. Younger RH eggs suffered higher parasitism. The parasitic rate decreased with higher population of parasites.

Extracts taken from different parts of Mahogony seed showed some insecticidal property against hispa, but none was effective in terms of mortality rate. Seventy-three insecticides against BPH, 21 against hispa and 10 against YSB were found effective in the reporting year. Thirty-six (IRBPHN 10) materials were found promising against BPH.
BRRI dhan44 was identified as more susceptible than TN1 to GM. So, BRRI dhan44 can be used for rearing GM in the green house.

Plant Pathology Division

Survey and monitoring report showed that hybrid rice is more susceptible to different rice diseases at farmer's field. Five advance breeding lines such as IRAT-267, BR8219-15-1, BR8219-16-1, BR8219-16-2 and BR7372-30-1-1 were moderately resistant to virulent blast pathogen. Nizersail DA-25 was found resistant to bakanae disease, and Dud shar (Acc. no. 499) and Hunuman jota (Acc. no. 574) showed moderately resistant to blast disease. Among the high yielding exotic genotypes RG-BU-08-026 showed the best performance against the virulent BB isolates in Bangladesh.
One new and most virulent isolate of bacterial blight disease was found in Habiganj, Dinajpur, Mymensingh and Gaibandha districts. *Xa21* gene was found very effective against the most virulent BB isolates in Bangladesh. The gene combination of BB resistant pyramid line IRBB65 (*Xa4, Xa7, xa13* and *Xa21*) is compatible and effective for developing durable BB resistant rice variety in Bangladesh.
The blast pathogen population in Bangladesh is quite diversified in pathogenicity and the isolates of eastern region are more virulent than northern region. The genes *Pi9*, *Pita2* and *Pish* could be the candidate resistant gene for developing durable blast resistant rice variety in Bangladesh.

Among the BRRI released T. Aus varieties BRRI dhan42 and BRRI dhan43 showed the highest and BR26 showed the lowest recovering ability against tungro disease. Two rice variety Betichikon and Te-Quing showed moderately resistant against the sheath blight disease in detached tiller protocol. Tissue paper inoculation method may be an effective mass inoculation method for bakanae disease screening. Clipping method may be a good technique for mass screening of sheath rot disease. Streptomycin based bactericide may be effective in controlling BB in Bangladesh. Sandazim and Opal successfully control sheath blight disease both at Gazipur and Rajshahi location. Bavistin 50 WP was found equally effective for both seed and seedling treatment in controlling bakanae disease. Neem and Mahogani seed extract reduced damaged tiller, ufra 1, ufra 2 and subsequently increased yield.

There is a highly significant and positive correlation (R= 0.99) between disease severity and yield loss due to bakanae disease. A simple linear regression equation Y= a + bx may be used to determine yield loss due to bakanae. Where- Y: estimated yield loss (%); a: regression line intercept (constant); b: regression coefficient and x: disease incidence.

Program Area: Rice Farming Systems

Rice Farming Systems Division

A survey on existing cropping patterns was done in all the upazila of the country. Information on the cropping patterns under Chittagong, Cox's Bazar, hill tract region, greater Noakhali, Sylhet, Rajshahi and Rangpur dristricts have been reported during 2010-11.
On average annual income of landless and small farmers under interventions were increased by 28.88 and 32% respectively compared to base year data at FSR and D site, Kapasia, Gazipur. Higher income was associated with interventions of farming systems technologies, off-farm and non-farm activities.
Spraying of mango trees with fungicide increased yield by 23.9 kg/plant of landless farmers over the control trees. Rearing of goat increased the income of the landless farmers.

LCC-based N management practice increased average yield of BRRI dhan46 in T. Aman BRRI dhan28 in Boro season by 0.6 and 0.3 t/ha respectively and 20.70 and 20.20 kg N/ha could be saved in Aman and Boro season respectively. By growing different vegetables each farmer earned Tk 460 to 6,080.
Turmeric and ginger produced an average yield of 35 kg and 4.17 kg with an average gross margin of Tk 1,048 and 151 from a homestead area of 26.20 m^2 and 5.33m^2 respectively.
Fertilization in jackfruit trees improved production capacity and generated more cash than that of non-fertilized trees. On average, fertilized plants enhanced total return by 39.33 % over the control plants.
Mixed culture of Rohu, Silver carp, Grass carp and Sorputi produced 192.5 kg fish in a seasonal pond of 14-decinal.

The rice equivalent yield (REY) of DS rice-Wheat-Mungbean cropping pattern was significantly higher in permanent bed (10.04 t/ha) than conventional method (7.96 t/ha). BCR was found better in bed practices due to less cost involvement in different management.
Evaluation of different cropping pattern in medium highland irrigated ecosystems indicated that rice equivalent yield of Potato-DT Boro-T. Aman cropping pattern was the highest (17.39 t/ha), which was followed by Boro-Fallow-T. Aman (11.12 t/ha), Mustard-T. Aus-T. Aman (12.75 t/ha) and Boro-T. Aus-T. Aman (13.39 t/ha) cropping patterns.

Evaluation of *Sesbania* application and weed management in T. Aman rice in Boro-Fallow-T. Aman cropping pattern indicated that S*esbania* incorporation before T. Aman rice significantly influenced yield and yield contributing characters. *Sesbania* incorporation by applying herbicide at 30 days after seeding produced the highest yield (3.704).
The grain yield obtained from transplanting (3.2 t/ha) and dry seeding (3.9 t/ha) with 7-9 seeds/drop was statically similar. The transplanted rice occupied the main field for lesser period (103 days) than dry seeded rice (122 days). On the other hand, the seed to seed growth duration was higher in transplanting method (133 days) than dry seeded rice.

Selective herbicide at 15 DAS is sufficient for Aman rice production in Maize-DS Aus (brown manured)-DS Aman cropping pattern. One hand weeding was saved in Aman season, which might be due to weed suppression effect of *Sesbania* incorporated during Aus season. Maize intercropped with grasspea-DS Aus with herbicide followed by one hand weeding-DS Aman with herbicide followed by one hand weeding produced the highest rice equivalent yield (REY), which was 12.02 t/ha.

Under late situation, double transplanting done on the same day of normal transplanting (25 September in T. Aman and 25 February in Boro) produced significantly higher grain yield than that of normal transplanting in both T. Aman and Boro seasons. Effect of planting time and seedling age for DT Boro revealed that irrespective of seedling age planting of Boro rice on 20 February after potato produced higher grain yield than that of 28 February and 8 March planting. On the other hand, double transplanting of Boro rice with 75 days tiller increased the grain yield of 33, 21 and 13% over seedling age of 45, 60 and 75 days respectively.

In long term study with four cropping patterns, the Potato-Boro-T. Aman cropping pattern produced the highest REY (22.92 t/ha) and gross margin (242,100 Tk/ha) in Rangpur. On the other hand, Boro-T.Aus-T. Aman produced the highest REY (15.00 t/ha) and gross margin (130,500 Tk/ha) in Gazipur.
Productivity of three rice cropped cropping patterns indicated that highest total grain yield of rice was obtained from the cropping pattern, BRRI dhan28-BRRI dhan48-BRRI dhan46 (13.11 t/ha), which was about 41 and 17% higher than the pattern BRRI dhan28-Garopajam-Horabdi (9.31 t/ha =FP_1) and BRRI dhan28-Mala-Kalizira (11.25 t/ha= FP_2) respectively.
Several activities on validation and delivery of farming systems technologies were carried out in different locations of the country. The activity included promotion of improved cropping pattern packages, demonstration of poultry manure as a source of phosphorus fertilizer, promotion of improved varieties of

turmeric cultivation in the homestead and multilocation testing of BRRI dhan46-BRRI dhan29-Fallow cropping pattern.

Program Area: Farm Mechanization
Farm Machinery and Postharvest Technology Division

The field performance and economic analysis of versatile multi-crop planter (VMP) was evaluated for seedling of different crops including rice under various tillage conditions. Seeding and fertilizer application in lines simultaneously can be done by the VMP. It saved 12.59-82.36% fuel; 50-68% labour cost for land preparation and 12.68-75.24% labour cost for seeding and fertilizer application. The speed ratio of main shaft and rotor shaft was 1.33.

Cultivation management practice for different tillage options was evaluated in Aman 2010. Rice was transplanted at various tillage conditions ie conventional tillage, bed formed by shaper in puddled condition and strip tillage and bed planting in unpuddled condition. The results revealed that energy consumption in conventional tillage system was accounted 37-38% for fertilizer, 23-25% for tillage, 21-22% for irrigation and 15% for plant protection, whereas, in minimum tillage systems, 49-52% for fertilizer, 19-21% for plant protection, 6-12% for tillage and 16-17% for irrigation. 26 GJ ha^{-1} energy input was required for conventional puddling, whereas 19 GJ ha^{-1} for minimum tillage for the same output energy due to insignificant yield difference. Maximum output–input energy ratio was observed in strip tillage. Minimum tillage saves 25% energy and its increased energy use efficiency was up to 40%.

To establish maize conventional tillage, zero tillage by *naigla*, bed formed by VMP, and the strip tillage by VMP and three levels (100, 50 and 0%) of residue retentions were evaluated as treatments. Fuel consumption was significantly lower in bed planting and strip tillage plots. The highest cost for land preparation was incurred in conventional tillage (Tk 3,774 ha^{-1}) and the lowest (Tk 1,055 ha^{-1}) in strip tillage because of minimal fuel and labour requirement. The maize yield in the conventional tillage, zero tillage by *naigla*, bed formed by VMP and the strip tillage by VMP plots were 7.75, 7.00, 8.48 and 7.19 t ha^{-1} respectively. The benefit cost ratio of conventional tillage, zero tillage by *naigla*, bed formed by VMP, and strip tillage by VMP was 1.47, 1.08, 1.64 and 1.27 respectively.

Existing motor operated BRRI power winnower was modified to diesel engine operated power winnower. The capacity of the modified winnower was same as of the motor operated winnower. Moreover, farmers can use this winnower in rural areas where electricity is not available.

Bokto seeding technology was also evaluated during Boro 2010-2011 season. The field trial was conducted with BRRI dhan28 in Boro at BRRI HQ farm, Gazipur and seed rate was found 47 kg/ha. Seeding and fertilizer dispensing rate was also found uniform and placed at a proper depth. Crop yield was found to be 3.98 t/ha.
PTO seeder was evaluated with conventional tillage practice in Aus 2010-11 at Toke, Kapasia. There were three treatments, viz T_1-Full tilth DSR, T_2-Strip DSR seeding and T_3-Farmer's or conventional practice. The field capacity of the PTO seeder was found to be 0.155 ha/hr. The yields were found to be 3.41, 3.2 and 2.7 t/ha for T_1, T_2 and T_3 treatments respectively.

The seedlings for transplanter machine were raised on plastic tray and polythene sheet using wooden strip to form an individual seedling block to measure the seedling strength for successful operation of the mechanical rice transplanter. Rice husk, saw dust and sandy loam soil were used as seed covering treatment materials. Both dry and sprouted seed were used as treatment as well. The highest seedling strength was found for T_{14} (7.49) followed by T_6, T_3 and T_5 treatments respectively. The lowest seedling strength was found for T_{13} (4.19) followed by T_{10} and T_8 respectively.

Performance of the BRRI USG applicator was evaluated in six locations of the country in Aman 2010. Application capacity, machine maneuverability, drudgery, uniformity of placing, depth of placing, covering of the dispensed granule were observed. In the field test average walking speed of the operator was found to be 3.72 km/hr and field capacity was about 35 decimal/hr, whereas, manual USG application capacity was found to be 4.5 decimal/hr. Average depth of placement of the granule was around 6.32 cm. Although yield and yield contributing character was almost similar in all the treatments, USG produced about 0.5 t/ha yield advantage than prilled urea resulted in higher productive tiller as well as higher grains/m^2.

Program Area: Socio-economics and Policy

Agricultural Economics Division

BRRI dhan28 and BRRI dhan29 were the most popular varieties in Boro season. BR11 is still the dominant variety in T. Aman season, covering about 18% of the area. In Aus season, the area coverage of BRRI dhan28 was the highest (20.23%) followed by BR3 (5.91%). Among different BRRI varieties, BRRI dhan29 was the top yielder in both Boro (5.34 t/ha) and Aus (4.88 t/ha) seasons. Recently, some Hybrid and Indian varieties are being adopted in Boro and Aus seasons due to higher yield performance.
Farmers received comparatively lower amount of gross return from MV Aus owing to lower yield. MV T. Aman growers received higher net return due to better market prices.

Although area of hybrid rice was decreasing in all the production environments, it showed quite a bit increasing trend in flood prone area over the years. Yield of hybrid (5-7 t/ha) fluctuated in all production environments. But it was quite impressive than BRRI dhan28. Per unit cost of production of hybrid rice was a bit lower compared to HYVs. Farmers reported that frequent power disruption and lack of knowledge about hybrid rice cultivation were major problems.

Sub1 rice varieties in Aman season are an appropriate technology to avoid submergence problem in the flood-prone ecosystem. It could save around 13% cost over the farmer's traditional and long durable *Bolan* practice. Total production and marketable surplus was positively related with the farm size in both the regions, Marketable surplus of total production of Boro in both the regions were higher compared to Aman. The coefficient of elasticity of production with respect to sales was more than unity indicating that total production was an outstanding factor in determining the level of marketable surplus.

Out of four dominant cropping patterns, Fallow-Fallow-T. Aman and Fallow-Fallow-T. Aman/Fish covered 82 and 15% cropped areas respectively, and these popular patterns were practiced by participant and non-participant farmers. Overall income of participant farmers was 46% higher than that of non-participant farmers. Flashflood occurred during the third week of July and damaged about 25% rice crops at its tillering stage in Fatepur of Rangpur. Drought occured in around 16th August to1st week of October in T. Aman season and in Boro season during 15 February to 16 May destroying around 70% crops in Rajshahi.
Ecosystem wise allocation revealed that, lower amount of resources were allocated in Aus season than that of both Aman and Boro. Rice research programme under National Agricultural Research System (NARS) embraced very limited resources and insufficient capacity to carry out research activities and very limited scope to strengthen and develop its infrastructure and manpower.

Agricultural Statistics Division

In the reporting period BRRI dhan32, BRRI dhan40, BRRI dhan41 and BR11 were found most stable in T. Aman season, while BR3, BRRI dhan51 and BRRI dhan52 appeared to be unstable among the non-aromatic rice. In case of aromatic rice, BRRI dhan38 appeared to be most stable followed by BRRI dhan37.

BRRI dhan28 and BRRI dhan29 was the only most stable variety and BR1, BR2, BR6, BR8 and BR18 appeared to be unstable in Boro season. In case of fine rice BRRI dhan50 appeared to be below average stable in Boro season.
BR11, BR22 and BRRI dhan32, BR16, BRRI dhan28 and BRRI dhan29, BR9, BR16 and BR20 were found to be more preferable and cultivable varieties due to higher yield in T. Aman, Boro and Aus season respectively among the producers and producer cum consumers. Pure consumers were found to prefer rice varieties on the basis of taste slenderness and availability.
Two mathematical models have been developed for consumer and producer preference to rice varieties by using four locations/districts farmers' data of Bangladesh in terms of rice-deficit and rice-surplus areas. These two models used to determine factors affecting producers' decision on varieties for rice cultivation and can provide an indication of the factors affecting consumers' preference to rice varieties.
A total of 102 different analyses were performed during the reporting year. Besides, a number of maps were prepared using GIS and supplied to the scientists of other divisions whenever required.

Farm management Division

An experiment was conducted at the west Byde of BRRI farm, Gazipur in Boro 2010-11 season to determine the relative profitability of different N sources (PU and USG) and weed control methods (Herbicide Refit, Herbicide Super Clean and hand weeding) for rice cultivation in relation to labour utilization. BRRI dhan29 was used for experimental purpose. The treatments were arranged in a Randomized Complete Block design with three replications. All the parameters were significantly affected by the interaction effect of N-fertilizers and weed control methods except 1000-grain weight and straw yield. Irrespective of N-fertilizer, hand weeding produced the highest number of tiller. N-fertilizer had no significant effect on panicle number. In PU applied plot, Super Clean and hand weeding plot produced the higher number grain panicle^{-1} and the lowest in Refit applied plot. In USG applied plots, Refit produced the highest number grain panicle^{-1} followed by Super Clean and the lowest in hand weeding plot. Irrespective of weeding method, USG produced the highest number grain panicle^{-1}. Regardless of N- fertilizer, weed control methods had no significant effect on grain yield. Comparing N-fertilizers, it was observed that USG applied plot produced the highest grain yield than PU applied plot except Super Clean applied plots, where no significant difference between PU and USG applied plots. Application of Super Clean instead of Refit earned additional profit of Tk 480 ha^{-1}. Application of Super Clean instead of hand weeding earned additional profit was Tk 9,790 ha^{-1}. Application of Refit, instead of hand weeding, earned additional profit of Tk 9,310 ha^{-1} and application of USG instead of PU, earned additional profit of Tk 15,468 ha^{-1}. It may be concluded that application of herbicide Super Clean might be more profitable than herbicide Refit and hand weeding to control weed.

An experiment was conducted at the west Byde of BRRI farm, Gazipur in Boro 2010-11 season to investigate the maturity level of rice seed for quality seed production. BRRI dhan29 was used as test variety. Seed samples were collected at 28, 30,32,34,36,38,40,42 and 44 days after fifty percent flowering for maturity. Different qualitative characters such as percentage of high density grain, percentage of fresh seed soaked in urea solution, germination percentage and seed vigour index along with yield and yield components were studied. All the studied characters except tiller and panicle hill^{-1} were significantly influenced by harvesting time. These characters such as filled grains panicle^{-1}, seed yield and percentage of high density grain increased gradually with delaying harvesting time as well as increasing maturity. But the germination percentage and seed vigour index increased upto 34 DAF and then decreased gradually. Harvesting of rice seed at 30-42 days after flowering produced quality seed along with good yield.

An experiment was conducted in Aus 2010, T. Aman 2010 and Boro 2010-11 seasons at the west Byde of the BRRI farm, Gazipur to determine the cost and return of HYV rice cultivation in existing situation.

The rice varieties BR26, BRRI dhan41 and BRRI dhan29 were tested in Aus, Aman and Boro season respectively. It was observed that a total labour requirement for different operations was 268, 268 and 272 man-day ha^{-1} in Aus, Boro and Aman seasons, respectively. Total variable cost was Tk 76,150, 85,100 and 1,00,715 in Aus, Aman and Boro seasons respectively. Gross margin was the highest in the Boro season (Tk 1,12,285) followed by Aman (Tk 88,900) and the lowest in Aus (Tk 57,350) season. The cost of production of per kg rice was the highest in Aus season (Tk 16.9) followed by Aman (Tk 14.2) and lowest in Boro season (Tk 11.9). The BCR was 1.75, 2.04 and 2.11 in Aus, Aman and Boro seasons respectively.

This experiment was conducted at the west Byde of BRRI farm, Gazipur during Boro 2010-11 seasons to find out the seed effect of quality seed and farmers seed for seed production and probable yield gap. BRRI dhan29 and BRRI dhan47 were used as test varieties. The results revealed that yield could be increased 34.7 and 49.58% through the use of breeder seed and 31.14 and 47.04% through TLS for the production of BRRI dhan29 and BRRI dhan47 respectively.

Survey and monitoring of labourer's wage rate at different locations around BRRI HQ such as Joydebpur, Chowrasta, Salna, Board Bazar, Konabari were conducted throughout the year and observed that the average wage rate day^{-1} varies from Tk 300 to 350. The wage rate day^{-1} during the peak periods of the year was Tk 420 to 500 in May, Tk 250 to 350 in July-August and Tk 300 to 400 in December-January. During February to October 2010 the wage rate varied between Tk 200-250, 200-225, 200-250, 250-300, 250-300, 200-250, 300-400 and 350-400 at Habiganj, Rangpur, Rajshahi, Barisal, Sonagazi, Comilla, Satkhira and Khulna respectively.

In total 15,238 kg of rice was produced by this division of which 10,366 kg was seed and 4872 kg was mixed rice. This division also produced 8,444 kg breeder seed in collaboration with the GRS division.
BRRI had 461 labourers of which 229 regular, 232 irregular. In BRRI HQ, the number of total labourer was 277 of which 130 regular and 147 irregular. The institute had 274 ha of land of which 163 ha was cultivable. About 72.3 ha of land was utilized by different divisions in different season of which 8.2 ha in aus, 32.2 ha in Aman and 31.8 ha in Boro season. Total labour utilization in different divisions for research purpose was 58,817.5 man days of which 59.58, 35.20 and 5.23% were utilized for research, support service and holidays respectively. A total of Tk 64,35,089 and 38,01,901 and 5,64,523 were paid to the labourers for research work, support service works and leaves respectively. This division also maintained the aesthetic view of the office area by creating visible flower garden during summer and winter season.

Program Area: Technology Transfer

Adaptive Research

In T. Aman 2010, three advanced lines along with BRRI dhan33 and BRRI dhan39 as checks were tested in eight different locations of Bangladesh. Based on growth duration, grain yield, disease reaction, farmer's opinion and overall performance, advanced lines BR7323-4B-1 and BR7517-2R-27-3 were found suitable for proposed variety trial (PVT).
In Aus 2010, T. Aman 2010 and Boro 2011, SPDPs were conducted by using different BRRI varieties along with USG, LCC, AWD, drum seeder and poultry manure at different locations of the country under different programmes like SRRPP, BRRI core, AFACI, Climate change etc. Under these programmes, 421 demonstrations were conducted from where about 743 tons of quality seeds were produced and 190 tons were retained by the farmers for next year cultivation. About 75,546 farmers were motivated to adopt these technologies.

A special SPDP programme with LCC using BRRI dhan50 was undertaken in 59 upazilas of six districts of greater Mymensingh region in Boro 2011. The average grain yield of the variety was 6 t/ha. Total

produced seeds of BRRI dhan50 was 46,051 kg and retained seeds by the farmers were 15,580 kg for further use. A total of 3,257 farmers were motivated and 7,064 farmers showed their interest about BRRI dhan50.
A field trial was conducted to evaluate the performance of "Hashim dhan", which is locally popular in some areas of Mymensingh district, along with BRRI dhan46 and BRRI dhan49 during T. Aman 2010. Among the tested varieties, BRRI dhan49 produced the highest yield (4.35 t/ha) followed by BRRI dhan46 (4.07 t/ha) and the lowest yield of 3.60 t/ha was achieved by Hashim dhan. The growth duration of Hashim dhan was the highest (154 days) whereas this duration of BRRI dhan49 was 140 days, which is 14 days less than Hashim dhan.
The Adaptive Research Division (ARD) conducted 19 rice schools and 76 field days at differnt locations of the country in which 665 trainees (570 farmers and 95 SAAOs of DAE) and 15,000 persons participated respectively.A total of nine tons quality seeds of the current rice varieties were produced at the BRRI farm by ARD, which were used for adaptive trials in different locations of the country in Aus, Aman and Boro seasons.

Training

The Training Division has conducted 56 training programme in the reporting period with course duration from 1-day to 1-week depending on their nature and requirement. A total of 1,813 participants from different government and non-government organizations and farmers were trained through these courses. The highest number of participants was from the Department of Agricultural Extension followed by farmers. The overall improvement of knowledge of extension personnel through 1-week rice production training (RPT) was 248% and 154% for southern and northern region respectively. However, for the stressed environment it was 162%. From 1974 to June 2011, BRRI completed 2,311 training programmes through which 64,301 participants were trained on different aspects of rice production technologies. The trainees expressed positive views about the course content and method of training. Most of the BRRI's speakers' performance was very good. A 3-day workshop on development and utilization of Bangladesh Rice Knowledge Bank (BRKB) was organized.

Workshop Machinery and Maintenance Division

The self-propelled reaper must have a self-power unit and power transmission mechanism. The marginal farmers of Bangladesh cannot afford to buy an imported self-propelled reaper due to higher initial cost. Therefore, to reduce the cost, a simple power transmission gearbox using locally available materials, has been designed. For easy power transmission, mechanism of two forward and one backward speed have been designed in it. At present it is under fabrication process at BRRI Research Workshop.
A total of 27 vehicles (4-wheeler) in 86 times, motor cycles in nine times, tractors/ power tillers/hydro-tillers in 15 times and others were repaired and spare parts were changed in BRRI workshop and outside BRRI under major repair and maintenance work. The total cost of major repair and maintenance work was Tk 26,33,132 from July 2010 to June 2011. Besides, day to day moderate/minor repair and maintenance works of all the vehicles and different farm machinery in BRRI were also done. In total 1868 numbers of moderate/minor work was done. The total cost of moderate/minor repair and maintenance was Tk 3, 22,921 from July 2010 to June 2011.

Regional Station
BRRI RS, Barisal

In observational trial BR7449-10-3-1, BR7449-23-2-1, BR7449-30-2-1 and BR7460-5-5-3 are the most potential lines having taller plant height suitable for tidal ecosystem.
In preliminary yield trial BR7606-5-5-2 have higher yield potential and taller plant height than the check BRRI dhan44.

In advanced line adaptive research trial BR7608-9-2-1 and BR7610-26-1-1 perform better than the check BRRI dhan44. In Boro, RYT#1 BR7358-30-3-1 and BR7873-5*(Nils)-51-HR6, BR7372-18-3-3 produced more than 7 t/ha yield with similar growth duration like BRRI dhan28. Considering grain yield and yield components, BRRI dhan49 may be suitable variety in tidal submergence condition. Poultry litter treated plots produced highest yield both in T. Aman and Boro season. P, K and S missing treated plot from complete fertilizer significantly decreased grain yield. Fartigation may increase plot compared to broadcast. Water salinity increased expotentially with the decrease in distance from the coast.

A total of 752 kg of BRRI dhan46 and 2014 kg of BRRI dhan29 quality seeds were produced from two sites in T. Aman and Boro 2010-11 seasons respectively under climate change project.
Thirteen field days conducted during T. Aman and Boro 2010-11 and participated 2340 real farmers, locally elected representatives, NGO representatives, BRRI, DAE personnel and all the farmers' shown their interest to grow the BRRI varieties if the seeds are available in the next season under southern coastal region rice cultivation and Production Increase Programme (SRRPP).
In Aus, T. Aman and Boro seasons of the reporting period the suitable varieties for Barisal region TLS 832, 1700 and 1300 kg were produced respectively and T. Aman and Boro seasons 1360 and 12500 kg Breeder seeds were produced.

BRRI RS, Comilla

Thirty-three crosses were made and 21 were confirmed and 304, 201, 670 and 97 plant progenies with desirable plant type and high yield potential were selected from F_2, F_3, F_4 and F_6 generations respectively under the varietal development programme. Five genotypes along with two checks were evaluated for medium stagnant water stress in T. Aman season. Two genotypes viz BR7611-9-3-2-1 and BR7611-21-3-6-1 were selected for further evaluation.
In RYT trials for T. Aman, genotype BR7875-5*(NIL)-52-HR1 was selected for early growth duration while genotype BR7878-5*(NIL)-37-HR2 was selected for earliness with Dadkhani grain type. BR7465-1-4-1 was selected for kataribhog grain type with medium growth duration. In RYT trials for PQR, Boro, two genotypes viz BR7358-5-3-2-1 and BR7358-56-4-1-3 were selected from RYT #1 for high yield with premium grade and similar growth duration of BRRI dhan28. On the other hand, two genotypes viz BR7372-18-2-1-HR1 and BR7372-18-3-3 were selected from RYT #2 with similar yield potential and growth duration of BRRI dhan28 but slightly higher yield than BRRI dhan50 with 5-6 days earlier in maturity. In the proposed variety trial (PVT) of Boro season two varieties viz BR7323-4B-1 and BW328 were evaluated against checks BRRI dhan28 and BRRI dhan29 by field evaluation team of National Seed board (NSB).
Nine and ten genotypes of hybrid rice were tested at the BRRI RS, Comilla as a part of multilocation trial in T. Aman and Boro seasons respectively. Their yield ranged from 1.13 to 4.37 and 7.6-10.0 t/ha with growth duration ranged from 148 to 167 and 107 to 130 days respectively. A total of 7,772 kg breeder seeds of BR11, BRRI dhan32 and BRRI dhan49 and 23,673 Kg breeder seeds of BRRI dhan28, BRRI dhan29 and BRRI dhan50 were produced.
Twenty-one T. Aman and 24 Boro rice varieties were evaluated at BRRI RS, Comilla farm to identify stability index. Considering yield performance, the top three varieties were BRRI dhan49, BRRI dhan44 and BR23 in T. Aman and BRRI dhan29, BRRI dhan45, BR3 in Boro. BRRI dhan49 produced an average yield of 5.22 t/ha in T. Aman in demonstration plots at seven farmers' field and BRRI dhan50 produced an average yield of 5.23 t/ha in Boro in demonstration plots at four farmers' field of Comilla region.

A total of 227 seven farmers (211 male and 16 female) of Comilla sadar south, Debidar, Daudkandi, Murad Nagar and B. para of Comilla district were trained by day-long six training programmes on rice production technologies. BRRI RS, Comilla participated in an agricultural fair of Comilla district.

BRRI RS, Kushtia

Six lines were tested in regional yield trial (RYT) in T. Aus. Among them the line BR7566-40-1-3 produced higher yield (4.61 t/ha) than the check varieties BR1, BR26 and BRRI dhan48. Growth durations of the lines were more or less similar to those of the check varieties except the lines BR7413-14-3-3 and BR7413-16-2-1.The yield of the proposed lines, BR7873-5*(Nils)-51-HR6 and IR74371-70-1-1) were found to be 4.8 t/ha and 4.7 t/ha respectively in T. Aman 2010. Growth durations of the lines were about one week earlier than the check.

The line IR83377-B-B-93-3 produced the highest (5.38 t/ha) and BR. Drought-1 produced the lowest (3.10 t/ha) yield in the participatory variety selection (PVS). Among the lines, IR83377-B-B-93-3, BR 7465-1-2-4, BR 7465-1-4-1 was scored as the first, second, third respectively by PVS function.
Yield of the tested hybrid entries ranged from 2.9 to 4.5 t/ha. Growth duration was 110-113 days for most of the entries except MLT10 (129) days. The highest number of panicles/m^2 (226.3) was obtained with the entry MLT5, which yielded 4.1 t/ha.

The yield of the proposed lines BR7323-4B-1, BW328 was found to be 6.9 and 7.01 t/ha respectively in Boro. Yield advantage was 0.35 t/ha for BR7323-4B-1 and 0.46 t/ha for BW328 over the check BRRI dhan28. BR7323-4B-1 produced 0.54 t/ha and BW328 produced 0.43 t/ha lower yield than the check BRRI dhan29. Growth duration was found in between two varieties BRRI dhan28 and BRRI dhan29.
BRRI dhan33 (short duration variety) and BR11 (long duration variety) were tested with four different transplanting dates to observe drought severity and to find out suitable date of transplanting under climate change situation. Drought at ripening stage was found less harmful for rice than the vegetative and the reproductive stages. Both short and long duration T. Aman varieties suffered less drought and showed good yield performance when transplanted on 17 to 24 July.

BR11 was established through supplemental irrigation on 18 July 2009 (T_1). In another treatment (T_2), the variety was transplanted under rainfed condition and it was 13 days later than that of T_1. The early transplanting of T. Aman rice through supplemental irrigation ensured that T. Aman effectively mitigated the terminal drought occurred at the reproductive stage and at the vegetative stage during T. Aman season 2010. Yield loss was 0.67 t/ha due to terminal drought at reproductive stage in treatment T_2 and it was about 12 percent less than the treatment T_1.
Efficiency of natural enemies was studied at Kushtia sadar upazila in Aus and T. Aman seasons 2010. Only one species of parasitoid (*Elasmus* sp.) was found to infect the pest. Rate of parasitism was found to be 10.82% and about 17.07% in Aus and T. Aman respectively. Yield and growth duration of 21 BRRI varieties were studied. Among thems eight were found to give higher yields than the standard yield and the other varieties yielded lower than the standard yield. Highest yield was obtained with the BRRI dhan49 (5.42 t/ha) and the lowest with the BR5 (2.79 t/ha). Growth duration of some of the test varieties decreased (up to nine days as in the case of BR10), whereas in some verities it increased (upto 27 days as in the case of BRRI dhan46).
Yield of rice was slightly higher when USG was applied by applicator (T_1) than the other methods. Similar plant height and 1000-grain weight (TGW) were observed for all the treatments but the highest number of panicles was found in the treatment T_1. In total, seven farmers' trainings were conducted in which around 250 farmers participated. One field day was organized to demonstrate water management technologies. National agriculture day rally and discussion meetings were participated.

BRRI RS, Habiganj

Twenty-three F_7 plants from four F_6 s and 131 desirable homozygous plants from 18 F_7s of deep water rice (DWR) were selected. BR224-2B-2-5(2.5 t ha^{-1}), BR224-2B-2-5 (3.2 t ha^{-1}), BR5925-B-2 (2.9 t ha^{-1}), and BR5915-B-34 (3 t ha^{-1}) yielded higher than HbjAIV (2.7 t ha^{-1}) with almost similar survivality.

Bazail-65 (3.1 t ha^{-1}), and Gabura (3.2 t ha^{-1}) yielded higher than HbjAIV (2.9 t ha^{-1}) that showed stable yield for last five years trial with higher survivality in secondary yield trial.

In Boro season, 135 F_6s plant were selected from 18 F_5s with high yield, short duration, tall plant type and strong culm. Another 176 F_6s plant were selected from 11 crosses with high yield, short duration, tall plant type and strong culm. Fifty F_4 plants were selected from F_3 population with desirable characters for the development of varieties suitable for *haor* areas. One of the lines, BR7226-19-1-3 (7.84 tha^{-1}) yielded higher with six days earlier, but BR7226-19-1-3 (7.90 tha^{-1}) and BR6839-41-5-1 (7.70 t ha^{-1}) yielded higher than BRRI dhan29 (7.43 t ha^{-1}) with similar growth duration in AYT, Boro. In RYT (Hbj) Boro, yield of all tested entries were lower than BRRI dhan29. But one entry yielded as BRRI dhan29 (7.54 t ha^{-1}) with six days earlier growth duration. BR7358-30-3-1 (7.4 t ha^{-1}) yielded higher than BRRI dhan28 (6.3 t ha^{-1}) but five entries (BR7358-5-3-2-1, BR7358-19-1-2, BR7358-56-4-1-3, BR7358-56-4-1-5 and BR7873-5(Nill)-51-HR6) yielded closed to BRRI dhan28 with similar growth duration in RYT #1 HQ. But in RYT#2 HQ, none of the lines out yielded BRRI dhan28 (6.27 t ha^{-1}) and BRRI dhan29 (7.36 t ha^{-1}) but tested entries yielded higher than BRRI dhan50 with 4-7 days earlier growth duration. In missing element trial the highest rice yield (8.6 t ha^{-1}) was obtained with complete fertilizer dose of NPKS and the lowest rice yield (5.0 t ha^{-1}) was obtained with all missing treatment. The highest rice yield of 8.2 t ha^{-1} was obtained with 80 kg ha^{-1} and the lowest rice yield 7 t ha^{-1} was obtained with 20 kg ha^{-1} dose of K.

In PVS trial BRRI dhan29-SC3-28-L16-PI-10-11 was preferred by the farmers due to higher grain yield (6.4 t ha^{-1}) and shorter growth duration (142 days) than the check BRRI dhan28 (6.2 t ha^{-1}, 150 days). In PVT (Boro 2011), none of the lines out yielded BRRI dhan29 (10.4 t ha^{-1}). But tested two lines BR7323-4B-1and BW328 yielded higher (1.10 t ha^{-1}) than BRRI dhan28 with same growth duration.
About 85 tons seeds of different varieties including breeder's seed were produced during the reporting year. In stability analysis trial the highest yield was obtained from BR15 (8 t ha^{-1}) followed by BRRI dhan29 (7.19 t ha^{-1}), BR14 (6.78 tha^{-1}) BR19 (6.67 t ha^{-1}) and BRRI dhan35 (6.61 t ha^{-1}).

BRRI RS, Rajshahi

Among the OYT materials under severe drought stress at reproductive stage, IR833377-B-B-93-3 (3.4 t/ha), IR83376-B-B-130-2 (3.3 t/ha) and IR83388-B-B-8-3 (3.2 t/ha) and in irrigated condition, IR83388-B-B-8-3 (5.3 t/ha), IR83376-B-B-86-3 (5.1 t/ha), IR83383-B-B-141-4 (5.0 t/ha), IR83383-B-B-141-2 (5.0 t/ha) were found better. In AYT experiment (100-120 days), IR83614-427-B (3.2 t/ha), IR80461-B-79-3 (3.1 t/ha), IR83614-143-B (3.4 t/ha) and IR83614-879-B (3.6 t/ha) produced better yield in stress. IR83614-798-B and IR80973-B-186-U1-2 produced similar yield and growth duration of BRRI dhan33 (ck) in irrigated condition. Again the AYT materials over 120 days, IR80416-B-152-4, IR84882-B, IR78555-3-2-2-2 and IR82948-14 (DT44015-14) out yielded Apo where other checks could not be flowered in stress but in irrigated condition IR84895-B, IR78875-207-B-3-B (4.7 t/ha) and IR80463-B-39-3 (4.5 t/ha) produced similar yield of BRRI dhan33 and higher yield than BRRI dhan39 and BINA dhan7. AYT-soma clone showed BRRI dhan29-SC3-28-L4-HR2 as the best among all test materials.
In hybrid evaluation (TA), IR82372H and IR81956H out yielded BRRI dhan33 and BINA dhan7 in irrigated condition. PVS indicated that IR74371-70-1-1, IR74371-54-1-1 and BINA dhan7 were the 1st, 2nd and 3rd respectively in Godagari. In Nachole, BRRI dhan32 was the preferred variety than Barkhe3004. In another PVT, the highest yield was recorded with soma clone line but highly susceptible to cold, spikelet abortion at the panicle tip and panicle emergence was twisted.

In RYT experiments results BR7873*5 (Nils)-37-HR4 (112-128 days and MS grain) was superior both for growth duration and yield than BRRI dhan33 (ck). The yield of five genotypes (135-142 days and LS grain) BR7877-*5 (Nils)-63, BR7877-*5 (Nils)-64, BR7150-11-5-4-2-11, BR7150-11-7-4-2-12 and BR7150-11-3-4-2-19 was better than BRRI dhan39 (ck). None of the genotypes (Growth duration 135-142 days and Dadkhani type) were out yielded BRRI dhan49 (ck). However, majority of the test lines

produced higher yield compared to the check Dadkhani and BRRI dhan34. In T. Aus, BR7414-25-1 and BR7414-22-1 were better than the check BR26 and BRRI dhan48. For crop-soil-water management among the nine tested entries, fertilizer response was higher in IR74371-54-1-1, BR7155-20-1-3 and IRRI123 including Guti Swarna and BRRI dhan49 (ck). Increased fertilizer level with increased yield was observed in all entries growth duration increased with increased seedling age. Thirty-five and 45-day-old seedlings reduced grain yield for all the test lines and varieties compared to 25 days. However, age effect was the greatest in Guti Swarna and BRRI dha49 and least in IRRI123. Genotypes and planting dates and their interaction were significant. For transplanting the test entries 15 July-5 August appeared to be the suitable time. However, IR74371-54-1-1 produced consistently higher yield up to 15 August.

For pest management most of the pyramid lines showed resistant reaction against the BB pathogen under natural condition except for IRBB59 and IRBB64. Out of nine fungicides, seven fungicides found effective against sheath blight. Krizole was the best among them. Despite artificial inoculation in premium quality advance lines, the disease pressure was very low. However, BR7517-2R-2-1, BR7150-11-5-4-2-1, BR7358-56-2-2-1 and BR7372-18-3-3 showed resistance against sheath blight.
GLH, white leaf hoppers, BPH, white backed planthoppers, rice bug and stem borers were the most prevalent insect. Among the natural enemies, carabid beetles were the most prevalent predator followed by ladybird beetles, earwig and staphylinid beetle. YSB was the predominant species followed by dark headed borer and pink borer. DHB seems to be emerging threat in Godagari and Tanore areas.
In rice farming systems trials the highest mean yield (4.04 t/ha) was obtained when rice was established with dry seeding method with bed planting system followed by conventional transplanting (3.87 t/ha). No significant variation was recorded for yield and yield components. However, the highest yield was recorded in bed planting to conventional transplanting. SSNM in Boro rice results that omission of any one of N/P/K significantly reduced grain yield of BRRI dhan28 compared to full NPKSZn. However, no significant variation of yield recorded for reduced K, missing S and Zn. Tiller, panicle and yield was the highest with full NPKSZn and the lowest with N missing. SSNM trials indicated that highest grain yield of Rabi maize was achieved with full NPK followed by full NP with reduced K. The lowest mean yield (5.7 t/ha) was in N omission treatment. However, Kharif maize cultivation after potato harvest only reduced N (50%) is sufficient for obtaining better grain yield.

BRRI RS, Rangpur

Three submergence tolerant genotypes IR64-Sub1, Samba Mahsuri-Sub1, IR85260-391-1192 along with five standard check varieties BRRI dhan51, BRRI dhan52, BRRI dhan33, BINA dhan 7 were evaluated in three different planting conditions- Completely submergence for 16 days, Non-submergence (check) and Bolan (double transplanting). In completely submergence condition significantly higher grain yield was obtained with short genotype duration IR64-Sub1 (3.0 t/ha). The highest yielding genotypes were BRRI dhan52 (ck) (4.8 t/ha). In non-submergence condition the highest yield was obtained from BR11-Sub1 (5.8 t/ha). In bolan practice the highest yield was obtained from BR11-Sub1 (5.8). IR64-Sub1 showed shorter growth duration than BR11-Sub1. Similar yield was found with other Sub1 lines.

In total, 256 baby trials were conducted in the six submergence prone districts of Bangladesh. Out of 256 baby trials, results were obtained from 133 trials and the remaining 123 trials were damaged by flood and the farmers were not able to establish the trials. In these trials, duration of flooding ranged from 1-12 days. In established baby trials, BRRI dhan51, BRRI dhan52 and BR11-Sub1 produced the higher and similar yield. As the shorter growth duration Sub1-lines IR64-Sub1 produced satisfactory yield. Besides Sub1-lines in these trials Samba Mahsuri-Sub1 and IR85260-391-1192 showed better performance.

In Integrated fertilizer management trial T3V2 combination treatment (Fresh PL @ 6 t/ha + 1/3 of N +BRRI dhan 29) produced the highest yield (6.5 t/ha). Post flood fertilizer management showed the highest yield with N2K3 treatment in variety BRRI dhan51 and BR11-Sub1 but that was the highest with N2K2 in BRRI dhan52. It is noticed that N2 (nitrogen application at 10 days after de-submergence) produced more yield in all the varieties. However, top dressing of K increased yield in case of BRRI dhan52. The plant spacing 20 × 20 cm produced higher yield in submergence condition. IR85260-391-1192 gave the highest yield among the genotypes in plant spacing 20 × 20 cm.

Closer spacing produced the highest grain yield, irrespective of entries in rainfed condition. The second highest yield was obtained with 20 × 20 cm spacing. Samba Mahsuri-Sub1 appeared the highest yielder entry, which was followed by IR85260-391-1192.

The highest grain yield was recorded with T_2 (4 DAT) in BRRI dhan51. Treatments T_2 and T_3 performed similarly with all the varieties. The data revealed that all the tested varieties performed similarly under submergence stress in early growth stage of crop (seedling establishment stage).

BRRI dhan33 produced the highest yield with CA based ZTDSR that was 10-15% higher than conventional methods. Yield obtained from ZTDSR 5.4 tha^{-1}, 5.4 and 5.1 $tha^{-1}$from CTDSR and TPR respectively. Hybrid maize NK 40 produced the highest yield with conventional tillage methods than CA based ZT maize. The yield obtained from ZT maize 8.2 t/ha and 8.7 t/ha from CT maize. The highest yield of CT maize associated with cobs/5m2, 100- seed weight and grains/cob. The Stover yield was similar in CT maize (10.2 t/ha) and ZT maize (10.0 t/ha).

Reduced (PTOS) tillage practices produced the highest grain yield (5.8 t/ha) respectively with zero, strip and conventional tillage. Pre-emergence of Topster produced the highest grain yield (5.8 t/ha) within four herbicides. The highest cost was found in conventional tillage practice and the lowest was found in reduced tillage practices. Reduced tillage by power tiller operated seeder (PTOS) was cost sawing for dry DSR but seeder was not available, so strip tillage was also economic and easy. A total of 74,276.36 (68276+6.36) ha land were cultivated the GO-NGO collaboration during the reporting period. Department of Agriculture Extension (DAE) achieved 68,276 ha land in five districts with four short duration varieties using transplanted condition. Rangpur and Nilphamari have the highest area of total target plan. BRRI-NGO achieved 6.36 ha by direct seeded condition in different area, with two short duration varieties to give their target plan.

A training with 30 farmers, sub-assistant agriculture officer (SAAO), NGO staff and two workshops with additional director of Rangpur region, deputy director of five districts, NGO officers and BRRI staff were conducted.

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A total of 8,181 kg breeder seeds of four varieties (2,345 kg of BRRI dhan33 and 1,331 kg of BRRI dhan39, and 2,715 kg of BRRI dhan45 and 1,790 kg of BR16 in T. Aman and Boro respectively) and

7,491 kg TLS of sixteen varieties both in T. Aman and Boro were produced and disseminated during 2010-11. N is the major yield limiting factor for Aman and Boro seasons under the Sonagazi farm soil. BRRI dhan54 produced 3.58 t/ha with STB fertilizer followed by STB with 25% more MP fertilizer at MT stage (3.33 t/ha) and in BRRI dhan53 produced 2.42 t/ha with 25% less of STB.

Rainwater harvesting in a reservoir with 25 cm high embankment can conserve more water than without embankment, which could increase area to irrigate Rabi crops in the coastal area. Genotype BR7105-4R-2 produced the highest yield (8.4 t/ha) followed by BRRI dhan47 and IR72579-B-3-2-3-3 (7.9 t/ha). These two genotypes were moved variety release system as salt tolerant variety for Boro season.In Boro season, BB resistant genotype (Pyramid line) IRBB 55 performed better (2.13 t/ha) in natural condition against BLB disease. Cost of paddy production per kilogram was Tk 11.30, 14.18 and 16.13 in farmer's situation, at BRRI farm and its contactor's management respectively.