Research Progress 2019-20

Plant Breeding Division

Table 2

Research Progress 2019-20

Sl. No.	Research Progress	Expected Output
1	**Project I: Development of double haploid rice variety**	
	Expt.1.1 Development of low glycemic index (GI) rice variety through anther culture During T. Aman a total of 41 doubled haploids were grown in two OTs. Among them seven lines were selected for PYT. During Boro 2019-20, seven doubled haploids were grown as PYT and among them two lines were selected.	Low glycemic index (GI) rice variety will be developed from this experiment.
	Expt. 1.2 Development of salt tolerant rice variety through anther culture A total of 5799 and 7011 hybrid anthers from 12 crosses were plated on N6 and M10 media. In total 11 calli were obtained. No green plants were regenerated yet. Six double haploid fixed lines from BRRI dhan28/BRRI dhan61 cross were evaluated during Boro 2019-20 as OT. Among them three lines were selected for further evaluation.	Salt tolerant rice variety will be developed.
	Expt.1.3 Development of premium quality rice variety through anther culture A total of 7328 and 8306 hybrid anthers from eight crosses were plated on N6 and M10 media. In total of 22 calli were obtained but no green plant was regenerated. Fifteen crosses and a backcross were done and in total 648 seeds were harvested for future anther culture program. Nineteen doubled haploid (DH_2) lines were evaluated in T. Aman 2019. Among them 7 and 10 plants were selected from BRRI dhan38/Bashful and BRRI dhan50/Bashful cross.	Aromatic and fine grain rice variety will be developed.
	Expt. 1.4 Development of Aus rice variety through anther culture A total of 259 F_1 seeds were harvested from eight crosses for further anther culture.	Short duration, high yielding Aus rice variety will be developed.
	Expt 1.5 Development of antioxidant enriched black rice variety During Boro 2019-20, a total of 156 double haploid lines derived from a cross between BRRI dhan28 and Padi Kool were grown in the field. Among them 95 lines were selected for further evaluation	Antioxidant enriched black rice variety will be developed.
	Expt. 1.6 Development of high yielding favorable bore rice variety During Boro2019-20, four anther culture derived doubled haploid lines were evaluated in a PYT with standard checks to select agronomically desirable and high yield potential materials. Among them three lines were selected depending on the duration	High yielding rice variety for Aus, Aman and Boro will be developed through somaclonal variation.

Sl. No.	Research Progress	Expected Output
	and comparable yield with checks for further evaluation.	
2	**Project II: Development of rice variety through somaclonal variation**	
	Exp 2.1 Development of somaclone using EMS treated rice seed During Aus and T. Aman 2019, a total of 85, 148 and 105 EMS treated somaclonal plants (M_1SC_4) were selected from BRRI dhan48, BR11 and, Tilbajal, respectively. On the other hand, during Boro 2019-20, a total of 52, 16, 111 and 25 EMS treated somaclonal plants (M_1SC_4) were selected from BRRI dhan28, BRRI dhan29, BRRI dhan86 and BRRI dhan92, respectively.	High yielding rice variety for Aus, Aman and Boro will be developed through somaclonal variation.
	Exp 2.2 Development of high yielding Aus variety through somaclonal variation A total of 165 somaclone lines (SC_4) developed from BRRI dhan48 were evaluated during Aus 2019. From them 65 plants were selected for further evaluation. Nine fixed somaclonal lines were evaluated during Aus 2019 season as PYT. From them five lines were selected for further evaluation.	High yielding Aus variety will be developed.
	Exp 2.3 Improvement of BRRI dhan47 through somclonal variation During Boro 2019-2020 six somaclonal lines developed from BRRI dhan47 were evaluated as PYT. Among them four lines were selected for further evaluation.	Shattering reduced BRRI dhan47 will be developed.
	Exp 2.4 Development of antioxidant enriched rice variety through somaclonal variation A total of 161 (SC_4) and 82 (SC_3) antioxidant enriched plants were selected during T Aman 2019. On the other hand, a total of 66 (SC_3) and 81 (SC_2) antioxidant enriched plants were selected during Boro 2019-20.	Antioxidant enriched high yielding somaclonal rice variety will be developed.
3	**Project III: Development of rice variety through wide hybridization**	
	Expt 3.1 Development of rice variety through wide hybridization followed by embryo rescue In total, 35 pedigree lines developed from wide hybridization were grown during T. Aman/2019. From them, a total of 72 plants were selected. A total of 11 back crosses were done with previously embryo rescued plants to reduce hybrid sterility and 424 BC_1F_1 seeds were harvested.	Different stress tolerant rice variety will be developed through wide hybridization
4	**Project IV: Rice transformation studies**	
	Expt.4.1 Development of salt tolerant transgenic rice **Development of salt tolerant transgenic rice with *GlyI and GlyII*** After transformation with *GlyI and GlyII* genes five plants were confirmed by GlyI and GlyII primers and sequencing. Fifteen T_3	Salt tolerant rice lines will be developed through genetic transformation.

Sl. No.	Research Progress	Expected Output
	seeds were harvested for further evaluation.	
	Expt.4.2: Introgression of salt tolerant mangrove gene *AeMDHAR* salt tolerant gene (from mangrove plant) containing transgenic MT24 was crossed with BRRI dhan28, BRRI dhan29, BRRI dhan67, BRRI dhan86 and BINA dhan10 to introgress *AeMDHAR salt* tolerant gene. Four BC_2F_1 plants of BRRI dhan28 were confirm by gene specific primer.	Salt tolerant rice lines will be developed through genetic transformation.
	4.3 Development of salt tolerant transgenic rice with *PVA* A construct was made by using vacuolar ATPase (*PVA*) from a wild rice, *Porteresia coarctata* to develop salt tolerant transgenic rice variety. Established of regeneration system is essential for any transformation study. That is why regeneration system was optimized for three newly developed rice varieties e.g. BRRI dhan86, BRRI dhan87 and BRRI dhan89 for future transformation with Vacuolar ATPase (PVA) construct using different media combination.	Salt tolerant rice lines will be developed through genetic transformation.
	GENOME EDITING THROUGH CRISPR **4.4 Development of high yielding aromatic rice lines through genome editing** Two unique 20 nucleotide sequences from *BADH2* gene were selected for genome editing site using BLAST. Six primers were designed for three reactions based on selected 20 nucleotide sequences and the sequence of plasmid vector. Also, the cloning vector with two inserts was designed with SnapGene software.	Aromatic rice lines will be developed through CRISPR/Cas9 genome editing.
	4.5 Development of high yielding blast resistant lines through genome editing *OsEFR922* gene sequence was collected from NCBI. Two unique 20 nucleotide sequences from *OsEFR922* gene were selected for genome editing site using BLAST. Six primers were designed for three reactions based on selected 20 nucleotide sequences and the sequence of plasmid vector. Also, the cloning vector with two inserts was designed with SnapGene software.	Blast resistant lines will be developed through CRISPR/Cas9 genome editing.
5	**Project V: Allele Mining**	
	Expt 5.1 Identification of QTLs for taller seedling height Genotyping was done using 20 polymorphic primers with 184 F_2 individuals developed from a cross between BR11 x Sadamota (acc. no. 1576). From the mapping population a total of 36 pedigree lines were grown in T. Aman 2019 and from them a total of 11 plants were selected for further evaluation.	QTLs for taller seedling height will be identified for developing tidal submergence tolerant rice variety.
	Expt 5.2 Validation of a simple functional marker for fragrance in non-Basmati fragrant rice varieties A total of 71 selected F_2 progenies developed from a cross between BRRI dhan87 and Kalizira were screened against functional marker of fragrance gene *BADH2*. Among them 19 aromatic, 36 heterozygous and 13 non-aromatic progenies were identified.	Information generated from this study will be applicable for marker Assisted Selection studies for aromatic rice variety development.
	5.3Determination of Aromatic genotypes (SYT-1, Plant	Information generated

Sl. No.	Research Progress	Expected Output
	Breeding) with Functional marker for *BADH2* gene Among 18 SYT material supplied by the Plant Breeding Division, eight lines were identified as aromatic using functional marker.	from this study will be used for aromatic rice variety development.
6	**Project VI: Gene Pyramiding**	
	Expt 6.1 Gene pyramiding for resistance to bacterial blight (BB) Bacterial Blight (BB) gene pyramided two lines having three BB resistant genes (*Xa4, xa13* and *Xa21*) were evaluated as ALART at 10 locations in Boro 2019-20 with standard checks by Adaptive Research Division, BRRI.	Breeding lines possessing multiple BB resistance genes will be developed through Marker Assisted Selection
7	**Project VII: Gene Cloning**	
	7.1 Isolation and cloning of stress tolerant gene cDNA was synthesized from RNA of treated and control *Oryza rufipogon* plant to observed the expression level and to clone dehydration responsive element binding (*DREB*) gene. Besides, the experiment was conducted to observe the expression level of *DREB* gene under drought and cold condition at different time point (0, 1, 3, 6, 12 and 24 hours). In all conditions, the expression of *DREB* gene was same using RT-PCR. *DREB* gene expression under both the control and stressed condition indicated its presence in all conditions. That is why; DNA was isolated from 24 rice genotypes to identify the variation of *DREB* gene sequence in those rice genotypes. *DREB* gene was amplified with genomic DNA of twenty-four rice genotypes and then sequenced. Multiple alignment of *DREB* sequence was performed using CLASTALW by BioEdit software. The nucleotide sequences of *DREB* gene of 24 genotypes were highly conserved and three conserved regions was identified. Among 24 genotypes, 22 were separated into four groups: group I consist of seven genotypes, group II consist of five genotypes, group III consist of four genotypes and group IV consist of six genotypes. But Pokkali and Bina dhan10 did not make cluster with any group.	To identify drought, cold and salt tolerant genes
8	**Project VIII: C4 RICE DEVELOPMENT**	
	8.1 Identification of *Setaria* mutants losing C4 properties. This study is a background work for identifying major genes controlling C4 photosynthetic property. *Setaria italica* (Kaoun), being a C4 crop was chosen for this study since this is a C4 crop having comparatively smaller size and short life span. Therefore, we can handle more plants in small areas. Also, more generations can be carried out in shorter time. Other C4 crop such as sugarcane or maize has long duration and larger size requiring larger space and longer time to maintain several generations. Considering all these, a number of 6000 *Setaria*	C4 photosynthetic properties losing *Setaria italic* mutants will be identified which can be used for C4 rice development

Sl. No.	Research Progress	Expected Output
	seeds were treated with 20 mM NMU solution in three time points (2 hours, 3 hours and 4 hours) and transplanted to field to get M1 plants. Besides, 2000 seeds were planted untreated as control. Therefore, a number of 6000 M1 generation of *Setaria* plants were grown in the nethouse. Due to mutation stress some plants died afterwards in the plot. Higher the exposure time to the NMU created more death to the plants. Eventually M_2 seeds from were harvested 695 M_1 generation plants (499 plants with 2 hours NMU treatment, 171 plants for 3 hours treatment and 25 plants for 4 hours treatment).	

Genetic Resources and Seed Division (GRSD)

Table - 2
Research Progress 2019-2020

Sl. No.	Research Progress	Expected Output
Program Area 01: Varietal Development Program (VDP)		
3	**Sub-program area: Rice Germplasm and Seed**	
3.1	**Project: Rice germplasm conservation and management** • Collection of 144 germplasm. • Rejuvenation of 2,732 germplasm and characterization of 108 germplasm with 51 morpho-agronomic characters were completed. Besides, 168 newly collected germplasm were also characterized using BRRI germplasm descriptor under PBRG-NATP-2 project. A total of 26 new germplasm were registered as new accessions (from acc. 8,579 to 8,604) in Genebank. • Characterization of 50 local germplasm for boosting yield through trait discovery in changing climatic conditions. • Molecular characterization of 48 Boro germplasm using 55 SSR markers under PBRG-NATP-2 project along with 73 pigmented T. Aman germplasm using 28 SSR markers were performed. • Supply of 1,910 samples of which 1,448 accessions and 462 seed/non-seed of BRRI varieties for research and demonstration.	Long-term conservation of the rice germplasm and utilization for future research and breeding. Characterized and as well as conserved germplasm would be utilized in trait specific breeding program.
3.2	**Project: Seed production and variety maintenance** • All BRRI developed (90) and recommended (14) rice varieties were maintained as nucleus stock. • In total, 181.97 tons of breeder seed with tags of which 115.05 tons of 23 Boro, 54.59 tons of 31 T. Aman and 12.33 tons of 11 Aus varieties, respectively were produced during 2019-20. • At the same time, 156.820 tons of breeder seed of which 92.709 tons of 21 Boro varieties, 11.69 tons of 11 Aus varieties and 52,421 tons of 31 T. Aman varieties were distributed.	Maintenance of pure seed stock and supply of breeder seed to GO, NGO and private seed producing organizations according to their demand under Rice Seed Network of BRRI.
3.3	**Project: Exploratory and genetic studies** • Jirasail accessions collected from Bogura, Jashore, Rajshahi,	Estimated genetic

Sl. No.	Research Progress	Expected Output
	Nowgaon and Tangail along with BRRI dhan70 for T. Aman and BRRI dhan81 for Boro seasons as checks were evaluated as Preliminary Yield Trial (PYT). • Balam (acc. 516), Jesso-Balam (2464, 2472) and Sada Mota (7888) and Lal Mota (7889) were selected for Secondary Yield Trial (SYT). • Eleven aromatic rice germplasm along with standard check BRRI dhan34 were evaluated as PYT. • Thirty-four *Jhum* rice germplasm were characterized to study the selection criteria during Aus 2019.	variability, character associations, genetic relationships and selection criteria for yield and yield components of rice germplasm would be used for clear understanding of genetic makeup of the tested germplasm.
3.4	**Project: Documentation of technology** During the reporting year, 400 accessions were documented in computer through *Microsoft Office Excel* program with collected available information.	Characterized information of the germplasm could be utilized for selecting parent(s) in breeding program.
3.5	**Project: Out research activities** Text message (SMS) were sent through mobile apps to 73, 8 and 92 partners before Boro 2019-20, Aus 2020 and T. Aman 2020 seasons, respectively for breeder seed distribution through BRRI 'Rice Seed Network'.	The quality seed production related important/current problems at farmers' field would be solved.

Hybrid Rice Division

Table-2

Research Progress 2019-2020

Sl. No	Research Progress	Expected Output
	Program Area: Varietal Development Project: Material development, seed production and its distribution Duration: 2019-2020	
01.	One potential Boro hybrid rice variety selected through multi-location trials will be submitted to SCA as BRRI hybrid dhan8 having yield potentiality 9.5-10.0 t/ha coupled with slender grain and growth duration 145-150 days. Hopefully this variety will be released within year of 2022.	This variety will bring new hope for Boro growing areas of Bangladesh
02.	One new CMS (A) line was developed having diverse characters for T Aman season. Five new restorer lines were identified having high fertility restoration ability	This CMS and restorer lines will use for new hybrid rice variety development for T Aman season.
03.	CMS multiplication and seed production package development of promising CMS lines and hybrid combinations has been initiated	After study of commercial seed production feasibility, preliminary yield trials and multi-location trials will be conducted. Finally, selected

Sl. No	Research Progress	Expected Output
		combinations will submit to Seed Certification Agency (SCA) for registration as new release hybrid.
04.	A total of 10125 kg of F_1 seeds of BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan4, BRRI hybrid dhan5, BRRI hybrid dhan6 and BRRI hybrid dhan7 were distributed among farmers, department of agricultural extension and different seed companies through Head Quarter and Regional Stations of BRRI	Popularization of BRRI released hybrid varieties.
05.	Seed production program of BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan4, BRRI hybrid dhan5 and BRRI hybrid dhan6 was initiated at farmers level under Mymensingh, Gopalganj, Ishrdi (Pabna), Sirajganj, Sherpur, Rangpur, Kurigram, Naogaon, Dinajpur, Nilphamari, Barishal, Satkhira and Khulna district	Farmers can able to produce own F_1 seeds of BRRI released hybrid rice varieties and in such a way small entrepreneurship will be developed at farmers level
06.	Large scale marketing of BRRI released Boro and T. Aman season hybrid were started by ACI, Supreme seed, Ahasan seeds and JF Agro.	Availability of BRRI released hybrid in the market will be increased and help popularizing BRRI hybrid varieties.

Grain Quality and Nutrition Division

Table-2

Research Progress 2019-2020

Sl.	Research Progress	Expected output
	Program area / Project with duration	
1.	Determination of physicochemical and cooking properties of rice grain	A total of 128 breeding lines were analyzed and some of the promising lines were identified for higher milling yield, head rice recovery, size-shape, amylose content, protein content, elongation ratio and acceptable other physicochemical properties.
2.	Determination of physicochemical and cooking properties of Transforming Rice Breeding (TRB) lines	Under transforming rice breeding program, a total of 2957 (LST- Line Stage Trial 2603, OT-Observational Trial 137 and PYT-Preliminary Yield Trial 217) were received, processed and evaluated.
3.	Nutraceutical Characterization of newly released BRRI varieties	A total of 20 HYVs from BRRI dhan71 to BRRI dhan89 were fully characterized including physicochemical, cooking, mineral, fatty acid, amino acid and antioxidant profiling.
4.	Study on antioxidative and anticancer properties of	A total of 150 local ice germplasms

	pigmented (black, red, purple) rice varieties in Bangladesh	were characterized for antioxidant. parameters.
5.	Value addition and standardization of nutritional level in selected food items to mitigate malnutrition	1.Gluten free rice-based bakery items such as rice biscuit, rice cake and rice dry cake formulation and validation. 2.Formulation of gluten free energy dense rice biscuit (ED) 5-5.2.
6.	Determination of physicochemical properties and quality of puffed, popped and flattened rice from newly released BRRI varieties	Puffed and flattened rice were produced from 10 BRRI varieties to evaluate the quality of the indigenous products. Comparing few parameters such as fully puffed rice weight, length and breadth of puffed rice, increased percentage of length and breadth with BR16 (Std), it is ascertained from the results that BRRI dhan81is better in producing whole puffed rice followed by BRRI dhan80, BRRI dhan84 and BRRI dhan88. Among the tested varieties, in terms of weight of broken flattened rice, thickness, increased percentage of length, and volume of 50 g flattened rice, BRRI dhan84 showed the best performance comparing with standard BR16 and other varieties.

Agronomy Division

Table-2

Research Progress 2019-2020

Sl.	Experimental title	Expected Output/ Outputs
1	Effect of seed treatment with chitosan on the growth of rice seedlings in saline medium	Quality seedling would be produced (On going)
2	Effect of time of planting on growth, grain yield and yield components of BRRI developed popular T. Aus varieties	BRRI dhan48 gave about 0.5 t ha^{-1} higher grain yield over ck BR26 and BRRI dhan82 with growth duration 112 days planted on 10 May
3	Effect of time of planting on growth, grain yield and yield components of advanced lines of T. Aman rice	Rainfed Lowland Rice (RLR) line, BR8841-38-1-2-2 transplanted in 15 July gave the highest grain yield (5.40 t ha^{-1}) within 127 days. Zinc Enriched Rice (ZER) line BR8436-7-4-2-3-1 planted on 15 July produced the highest grain yield (5.56 t ha^{-1}) followed by BR8442-12-1-3-1-B7 (5.50 t ha^{-1}) with growth duration 126 days and 136 days, respectively. Biotechnology ALART lines didn't produced higher grain yield over ck BRRI dhan71 and BRRI dhan87.

		Biotechnology RYT line BR(Bio)10376-AC11-3-1 produced identical grain yield with BRRI dhan71 from 1 August to 16 September with delaying 2-3 days.
4	Effect of time of planting on growth, grain yield and yield components of advanced lines of Boro rice	Biotechnology ALART, PQR lines BR8862-29-1-5-3, BR8995-2-5-5-2-1 were statistically identical with BRRI dhan50 and matured 1-5 days delayed. Biotechnology ALART, ZER line didn't gave higher grain yield than check
5	Effect of time of planting on growth, yield and yield components of Advance lines for Haor regions in Boro season	Advanced line for Haor region grown at Gazipur gave lower grain yield than check variety, but matured 4-20 days earlier than BRRI dhan28
6	Effect of time of planting on yield and yield contributing factors of BRRI released varieties in Boro season at Haor region of Bangladesh	In Haor region BRRI dhan67 followed by BRRI dhan89 produced the highest grain yield transplanted on December.
Sl.	**Experimental title**	**Expected Output/ Outputs**
7	Effect of seedling age on tiller dynamics of BRRI released varieties and its impact on yield	In Boro, BRRI dhan84 and BRRI hybrid dhan5 produced the highest tiller number and highest grain yield 8.44 t ha^{-1} and 8.01 t ha^{-1}, respectively with 45 days old seedling. In T. Aman, BRRI dhan71 and BRRI dhan87 produced higher grain yield 6.04 t ha^{-1} and 5.52 t ha^{-1}, respectively with 25 days old seedling.
8	Determination of economic fertilizer rate for popular transplanted Aus rice varieties	Economic fertilizer rate for BR26, BRRI dhan48 and BRRI dhan82 was determined as 88, 86 and 60 kg ha^{-1}, respectively.
9	Effect of nitrogen and potassium fertilizer management on growth and yield of mechanically transplanted Boro rice	BRRI dhan89 gave significant grain yield (7.30 t ha^{-1}) with 16% higher urea fertilizer in four equal splits and 1/3 MoP applied with 3rd top dress of urea along with BRRI recommended fertilizer management at BRRI farm Gazipur.
10	Effect of nitrogen management at the reproductive phase of rice	BRRI recommended management and treatment with 29.5 kg ha^{-1} as basal + 29.5 kg ha^{-1} at 15 DAT + 10 kg ha^{-1} at heading stag gave significantly higher grain yield, panicle m^{-2} and sterility (%).
11	Comparative performance of logo method and normal transplanting with different spacing	Line transplanting with logo method (line gap) after six, eight or ten lines with spacing 20 cm × 15 cm or 15 cm × 15 cm had no significant effect on grain yield and panicle number in T. Aman season.
12	Yield maximization of T. Aus rice through integrated crop management	BRRI dhan48 (4.53 t ha^{-1}) and BRRI dhan85 (4.43 t ha^{-1}) gave significant higher grain yield over BRRI dhan82 (3.46 t ha^{-1}) with integrated crop management (ICM) followed by BRRI

		recommended fertilizer (BRF) management
13	Screening of rice varieties for weed competitiveness in T. Aman and Boro season	In T. Aman season BR23 followed by BRRI dhan39 and In Boro season BR17 followed by BRRI dhan45 and BRRI hybrid dhan5 Hybrid Mollica and SL8 had higher ability to suppress weed in initial stage of rice growth.
14	Improvement of Soil Health in Four Crops Pattern through Agronomic Management	Mungbean (BARI Mung-6)- T. Aus (BRRI dhan48)-T. Aman -Potato (Cardinal) found more profitable in stress prone area Alimgonj (drought) and Amtoli (salinity) without losing the soil health/ fertility with proper agronomic practices.

Plant Physiology Division

Table - 2

Research Progress 2019-2020

Sl.	Programme area/ Project (Duration)	Expected output
1. Salinity tolerance		
Expt. 1.1	Salinity tolerance of 3K Rice Genome Project Bangladeshi panel at seedling stage	Four entries (UCP 122, BORO 394, PANKAIT 31 and BRRI 335) showed moderately tolerant (SES score≤5) with shoot Na+/K+ ratio ranged from 1.01 to 1.61.
Expt. 1.2	Exploring new sources of salinity tolerance from BRRI Gene Bank germplasm at the seedling stage	Four hundred and twenty-one (421) germplasm were screened for seedling stage salinity tolerance at 12 dS/m according to (Gregario et. al., 1997) along with standard tolerant check IR58443-6B-10-3 and responsive cheek IRRI 154. Among them 50 germplasm) were found to be moderately tolerant (SES score 4.0-5.0).
Expt. 1.3	Screening of advanced breeding lines for tolerance to salinity at the seedling stage	Three hundred and thirty-five (335) advanced lines from different sources (plant breeding division, plant biotechnology division and hybrid rice division) were screened along with standard tolerance check IR58443-6B-10-3 and responsive check IRRI154 for seedling stage salinity tolerance at 14 dS/m. Among them 43 were found to be tolerant to moderately tolerant (SES score 3 - 5.0).
2. Submergence tolerance		
Expt. 2.1	Identification of rice germlasm for two weeks flash flood submergence tolerance	Out of 120 germplasm only two germplasm (Acc. No. 1216 and 1301) was found moderately tolerant (SES score 5) having 77 percent survivability with non-elongating type. Advance line BR10230-1527-7B was found tolerant (SES score 1) having 100 percent survivability with non-elongating type. Tolerant check varieties FR13 A and BRRI dhan79 had 100% survivability.
Expt. 2.3	Identification of advance breeding genotype for flash flood submergence tolerance	Among the tested genotypes only two genotypes IR118194-B-17-3 and IR118194-B-3-3 were selected as their survivability were 55% and 48%, respectively, and

Sl.	Programme area/ Project (Duration)	Expected output
		SES score 7 and 9, respectively. The rest of the genotypes had 0-5% survivability with SES score 9.
Expt. 2.4	Molecular characterization of rice genotype in relation to submergence tolerance	Sixteen genotypes including the two tolerant checks (FR13A and BRRI dhan79) that possess Sub1A-1 allele, and the other twenty one genotypes possess Sub1A-2 allele. Genotypes having Sub1A-1allele can be used as a new submergence tolerant donor, and tolerant genotypes having Sub1A-2 allele can be further studied to discover the novel genes or QTLs.
Expt. 2.5	Screening of some advance breeding lines, germpalsm and some BRRI varieties under stagnant flooding (SF)	On the basis of tiller producing ability and survivability three advance breeding lines (IR16F1081, BR9175-9-2-1-12-5 and IR13F458-5), three germplasm (Acc. No. 1061, Acc. No. 1007 and Acc. No. 3956) and a variety BR23 performed better at stagnant flood condition.
3. Drought tolerance		
Expt. 3.1	Screening of rice germplasm for drought tolerance at reproductive phase, T. Aman2019	Out of 300 germplasm, 18 genotypes showed best performance in relation to yield under drought stress at reproductive phase.
Expt. 3.2	Confirmation of performance for advanced breeding lines under control drought condition at reproductive phase	Out of 9 RYT materials IR9880-Gaz-5-1-1-2 performed better.
Expt. 3.3	Evaluation of advanced breeding lines of deep water rice (DWR) under control drought stress at reproductive phase	Among the 5 RYT of deep water rice BR10260-7-19-2B showed better performance under drought condition.
Expt. 3.4	Evaluation of previously selected germplasm under drought stress at reproductive phase in the rain-out shelter	Out of 27 germplasm BRRI Gene Bank Acc. No. 1673 yielded highest followed by Acc. no 1630, 1684 and 1819 which have 1 to 3 tolerance score in previous year in the field that reveals a positive correlation with field performance.
4. Heat tolerance		
Expt. 4.1	Marker-assisted introgression of spikelet fertility QTL from N22 to two Bangladeshi mega rice variety BRRI dhan28 and BRRI dhan29	From second backcross generation, one moderately heat tolerant (SES: 5) homozygous line of BRRI dhan28 background was selected. From third backcross generation, 12 introgression lines at BC3F5 were selected with reference to the respective recurrent parents (BRRI dhan28 and BRRI dhan29).
5. Cold tolerance		
Expt. 5.1	Screening of rice genotypes for seedling stage cold tolerance	Among the tested rice genotypes, 37 BRRI GeneBank germplasm, two advanced breeding lines (TP7594, TP16199) and BRRI dhan45 showed moderately cold tolerant at seedling stage.
Expt. 5.2	Screening of advanced rice genotypes for cold tolerance at natural field condition	Out of 370 advanced breeding lines 63 rice genotypes showed cold tolerance at vegetative stage but only 26 genotypes were selected as moderately tolerant at

Sl.	Programme area/ Project (Duration)	Expected output
		reproductive phase.
Expt. 5.3	Screening of rice genotypes for reproductive stage cold tolerance in Phytotron	Cold treatment caused significantly higher sterility in all tested genotypes than tolerant checks. After cold treatment, sterility of BRRI dhan67 (48.3%), TP7594 (51.5%), TP16199 (53.3%) and BRRI dhan45 (55.4%) was lower than BRRI dhan28 (65.7%) and BRRI dhan36 (73.2%).
Expt. 5.4	Characterization and evaluation of some selected rice genotypes for cold tolerance	Early planting caused significantly higher sterility in all tested genotypes over tolerant checks. Sterility of TP7594 (45.2%), TP16199 (45.8%) BRRI dhan67 (58.4%), and BRRI dhan45 (55.4%) was lower than BRRI dhan28 (62.4%) and BRRI dhan36 (63.5%). Only two advanced rice genotypes TP7594 and TP16199 were found as moderately cold tolerant at reproductive phase.
Expt. 5.5	Optimization of sowing/ planting times of Boro varieties for minimizing cold injury	Seven BRRI varieties were evaluated in natural field condition using five sets of seeding time starting from 01 November at 10 days interval. To escape cold injury at reproductive phase BRRI dhan81and BRRI dhan88 should be sown after 3rd week of November. In contrast, early planted BRRI dhan89 and BRRI dhan58 could escape cold stress due to its longer growth duration.
6. Growth studies		
Expt. 6.1	Response to photoperiod of some advanced breeding lines	On the basis of relative photoperiod sensitivity among the twenty-four breeding lines 10 lines showed more than 83% Relative photoperiod sensitivity (RPS). BR9178-7-2-4-4 showed strong photosensitivity as like as Naizersail.
7. Yield potential		
Expt. 7.1	Physiological characterization for morpho-physiological traits of rice for improving yield potential of current high-yielding ideotype	Morpho-physiological traits of 11 and 13 rice genotypes were characterized during Boro and T. Aman season respectively. Results showed BRRI dhan29 produced highest number of spikelet/m^2 (48,298). The highest total dry matter (15t/ha) was recorded from BR(BIO) 9786-BC2-65-1-1.
Expt. 7.2	Investigation of photosynthetic capacities of C3 and C4 species	Results revealed, Shayma maintained higher net CO2 assimilation rate but maintained significantly lower intercellular CO_2 concentration. Again, Shayma maintain lower stomatal conductance than C3 species (rice and uridhan), and have lower rates of water loss per unit of carbon fixed and higher water-use efficiencies. Interestingly, Uri dhan showed intermediate values for net assimilation rate, intercellular CO_2 concentration and stomatal conductance but have higher transpiration rate compare to rice (C3) and Shayma (C4). In terms of photosynthetic efficiencies, all tested species showed similar effective quantum yield of PSII under steady-state condition but Uri dhan showed significantly lower electron transport rate (ETR).

Sl.	Programme area/ Project (Duration)	Expected output
Expt. 7.3	Effect of seedling age on crop phenological development of some BRRI Boro varieties.	The short duration variety BRRI dhan81 and BRRI dhan88 gave higher yield when 40 days old seedling were used followed by 30 days old seedling. Over aged seedlings (50 and 60 days) gave lower yield. On the other hand, BRRI dhan89 had highest yield when 30 days old seeding were transplanted. Yield was decreased sharply when aged seedling was used. Irrespective of seedling age there was no significant difference in growth duration for short duration variety. On the other hand, BRRI dhan89 had lowest growth duration for the youngest (30 days old) seedlings but similar growth duration for 40, 50 and 60 days old seedlings
Expt. 7.4	Generation of male sterile rice line for two-line hybrid system by editing TMS5 gene using CRISPR/Cas9 system	To design a CRISPR/Cas9 targeting the *TMS5* gene in rice, a 19bp nucleotide sequence (5′-ACCGTCGAGGGCTACCCCG-3′) was a protospacer adjacent motif lying within the *TMS5* coding sequence (LOC_Os02g12290.1). The target site was ligated with an intermediate vector SK-gRNA.

Soil Science Division

Table-2
Research Progress 2019-20

Research Progress	Expected output
Program Area: Crop-Soil-Water Management	
Project 1: Fertility Assessment of Rice Soils and Nutrient use efficiency in rice	
Expt.1.1. Increase N use efficiency through nanotechnology A pot experiment was conducted in BRRI Soil Science glasshouse, to evaluate rice grain yield and N use efficiency of typically synthesized urea-HA (hydroxyapatite) nanohybrid and urea plus purified natural zeolite (71% SiO_2) over prilled urea using terrace paddy soil of BRRI, Gazipur during 2020 Boro season. Urea-HA nanohybrids was synthesized according to Kottegoda et al. (2017). Transplanted rice (BRRI dhan89) was grown in the glasshouse under continuous flooding for 118 days. Five treatments were tested viz. PKSZn, Urea-N_{120}PKSZn, Nano fert.-N_{120}PKSZn, Nano fert.-N_{60}PKSZn and Urea-N_{120}PKSZn + purified natural zeolite (71% SiO_2) @ 2.5 t ha^{-1}. Among the yield contributing parameters only the grain and straw weights (yields), hence total yield per pot were significantly ($p<0.05$) varied among the five treatments. Agronomic efficiency (AE_N) (kg grain kg^{-1} N applied) calculated only from T_5(16), and no additional benefit in grain yield was obtained from urea and urea-HA nanohybrids applied pots over N unfertilized pot. Therefore, application of urea-plus zeolite may increase rice grain yield and N use efficiency over prilled urea and urea-HA nanohybrids, but require further verification by using more paddy soils and field trials.	Evaluation of N use efficiency of typically synthesized urea-HA (hydroxyapatite) nanohybrid over prilled urea for optimum rice yield.

Expt.1.2. Fertilizer management for premium quality Boro Rice Field experiment was conducted to develop an INM/IPNS based fertilizer management package for fine aromatic T. Aman rice and to maintain the grain quality. Eight different fertilizer treatments combinations viz; control, STB fertilizer, cowdung (CD) 1t ha^{-1}+ IPNS, CD 2t ha^{-1}+IPNS, CD 3t ha^{-1}+IPNS, CD 1t ha^{-1}+ 75% STB, CD 2t ha^{-1}+50% STB, CD 2t ha^{-1}+ 50% STB, and CD 3t ha^{-1}+ 25% STB were assigned in split plot design with 3 replications. Result showed that, BRRI dhan80 gave 4.41 t ha^{-1} grain yield in CD 2t ha^{-1}+ IPNS and it was statistical similar with all other treatments except control, however in the same treatment, BRRI dhan34 produced significant the highest grain yield (3.89 t tha^{-1}), though it was statistical similar with application of CD 2t ha^{-1} + 50% STB. Kataribhog produced 3.12 t tha^{-1} and 3.11 t tha^{-1} in CD 2t ha^{-1}+ 50% STB and CD 3t ha^{-1} + 25% STB, respectively, however it was similar to application of 1-2 CD t ha^{-1} + IPNS treatment.	Determination of appropriate fertilizer management for premium quality Boro Rice for optimum yield and quality.
Expt.1.3. Nutrient management for growing four crops in a year Experiment has been initiated in T. Aus 2016 to grow four crops in a year for sustainable soil fertility status as well as increasing productivity. Three fertilizer treatments, Soil test based (STB) fertilizer (T_1), crop residues (CR) + STB fertilizer (T_2) and fertilizer control i.e. native soil nutrients (T_3) were tested with Mustard-Boro-T. Aus-T. Aman and Mustard-Mungbean-T. Aus-T. Aman patterns. Experiment design was randomized complete block with 3 replications. First crop Mungbean was incorporated in T_2 treatment. After two crop cycle, T_1 and T_2 treatments gave similar yield in each crop. In the 3rd year and 3rd crop cycle, both cropping patterns were also giving their potential yield with AEZ based chemical fertilizer application (T_1) as well as with crop residue incorporation (T_2). After 4^{th}crop cycles, it is revealed that AEZ based or soil test based (STB) chemical fertilizers seemed sufficient to obtain potential yield of each crop under both patterns. In all cases, incorporation of crop residue had some positive impact on yield and hopefully on soil fertility than chemical fertilizer only. Considering REY and economics CP-1 (Mustard-Boro-T. Aus-T. Aman) performed better than CP-2 (Mustard-Mungbean-T. Aus-T. Aman) but requires long-term evaluation to observe the sustainable yield trends and soil fertility status.	Appropriate integrated nutrient management packages will be developed for triple and four crops-based cropping patterns.
Expt.1.4. Determining N requirement of ALART materials Before releasing a variety, ALART materials need to adjust fertilizer N requirement as N is the most limiting nutrients for rice production. Separate field trials were conducted for premium quality rice (PQR), Zn enriched rice (ZER) and favorable Boro (FBR) (biotechnology) genotypes at BRRI HQ farm, Gazipur (AEZ 28) during Aman and Boro of 2019-20 following split-plot design with 3 replications, where fertilizer doses were assigned in main-plot and rice genotypes in sub-plot. Two PQR lines BR 8862-29-1-5-1-3 and BR 8995-2-5-5-2-1, one ZER line IR 99285-1-1-1-P2 and two FBR genotypes BR(Bio)11447-1-28-14-3 and BR (Bio)11447-3-10-7-1 were evaluated. Six urea-N doses (kg ha^{-1}): N_0, N_{40}, N_{80}, N_{120}, N_{160} and N_{200} with standard doses of P, K, S were applied for each experiment. Quadratic regression model was used to determine optimum N requirement.	Determination of appropriate N rates for ALART materials for optimum rice yield.

Insignificant grain yield was obtained at 160 kg N ha^{-1} in two advanced PQR lines BR 8862-29-1-5-1-3 (5.52 t ha^{-1}) and BR 8995-2-5-5-2-1 (5.51 t ha^{-1}) with check variety BRRI dhan50 (5.23 t ha^{-1}). The calculated optimum N dose using Quadratic regression model for advanced lines BR 8862-29-1-5-1-3, BR 8995-2-5-5-2-1and the check variety BRRI dhan50 was 164, 167 and 165 kg ha^{-1} respectively, which proved N use efficiency of proposed PQR lines were similar to check variety. At 160 kg N ha^{-1}, significantly high grain yield was obtained in the advanced ZER line IR 99285-1-1-1-P2 (7.26 t ha^{-1}) compared to check variety BRRI dhan29 (6.69 t ha^{-1}) and BRRI dhan84 (6.24 t ha^{-1}). The additional grain yield 0.5-1.2 t ha^{-1} obtained with that N level in IR 99285-1-1-1-P2 line compared to check varieties directed it as N efficient ZER line. Among the FBR genotypes, significant grain yield 7.84 t ha^{-1} and 6.81 t ha^{-1} were obtained in BR (Bio) 11447-3-10-7-1 and BR (Bio) 11447-1-28-14-3 genotypes, respectively, compared to check variety BRRI dhan28 (6.06 t ha^{-1}) at 120 kg ha^{-1}N dose. The calculated optimum N dose for FBR lines BR (Bio) 11447-3-10-7-1, BR (Bio) 11447-1-28-14-3 and the check variety BRRI dhan28 was 133, 128 and 135 kg ha^{-1}, respectively which showed to some extent of N efficient characteristics.	
Expt.1.5. Determination of N dose for modern rice varieties The optimum N requirement of BRRI dhan87 and BRRI dhan89 was determined. The experiments were laid out in a RCB design with three replications. The applied N doses (kg ha^{-1}) for T. Aman was 0, 30, 60, 90, 120 and 150, and Boro was 0, 40, 80, 120, 160, 200 respectively, along with flat doses of P, K, S fertilizer. The estimated N and grain yield response function derived from quadratic regression analysis. The grain yield of BRRI dhan87 increased with increased N rates up to 90 kg ha^{-1}. The calculated optimum and economic N doses (kg ha^{-1}) of BRRI dhan87 were 84 and 83, respectively. The grain yield of BRRI dhan89 increased with the increased N rates up to 160 kg ha^{-1}. The calculated optimum and economic N doses (kg ha^{-1}) of BRRI dhan89 were 155 and 154, respectively.	Determination of appropriate N rates for newly released BRRI varieties for optimum yield.
Expt.1.6. Influence of nitrogen and potassium rates on performance of modern rice The objectives of the study were to find out suitable N and K ratio for MV rice cultivation and to study their dynamics in soil-and plant systems. Six years' study from T. Aman 2014 to Boro 2020 was conducted at BRRI HQ farm, Gazipur (AEZ 28) following split-plot design with 3 replications. K doses were assigned in the main plots and N in the subplots. Phosphorus and S was applied as blanket dose. In T. Aman, K was applied @ 0, 50, 100, 150 and 200 kg ha^{-1} and N @ 0, 50, 75 and 100 kg ha^{-1} respectively. However, in the Boro, K doses remained same, but N was applied @ 0, 100, 120 and 140 kg ha^{-1}. However, from the year, 2017, BRRI dhan72 and BRRI dhan74 were selected for T. Aman and Boro season, respectively. It was proved that increasing N significantly decreased grain yield in K deficient condition and in N deficient condition, K rates were not responsible for increased grain yield. It proved that in T. Aman, 50 kg K and 50 kg N combination is suitable to get optimum yield of BRRI dhan72. At Boro, application of N @ 120 kg ha^{-1} with 100 kg K ha^{-1} produced the highest grain yield of 6.17 t ha^{-1}.	Suitable ratio of N and K for MV rice cultivation will be developed with N and K dynamics in soil and plant.

Expt.1.7. Performance of rice varieties under P deficit conditions An experiment was conducted at BRRI farm, Gazipur with the objective to determine the performance of MV rice under different soil P levels. Soil available P level was grouped into four (1.70-2.30, 2.31-2.90, 2.91-3.50 and 3.51-4.10 mg kg^{-1}) where each level had three plots considered as three replications. Each plot received NKS as per recommended fertilizer doses. Main plots were considered as soil P levels and in the sub-plots 0 and 12 kg ha^{-1} P in wet season and 0 and 20 kg ha^{-1} in dry season were applied. Study result proved, in both inherent soil P and applied P conditions; BRRI dhan49 performed better than BRRI dhan87 in T. Aman and BRRI dhan89 showed better result than BRRI dhan92 in Boro season.	The more P efficient varieties will be identified by investigating the performance of MV rice under different soil P levels
Expt.1.8. Micronutrient status of some selected paddy soils of Bangladesh The study was undertaken with the objectives to determine the effect of micronutrients and beneficial nutrients on growth and yield of rice and to observe the interactions among the applied nutrients. A pot experiment was set up in the glasshouse of Soil Science Division, BRRI Gazipur. The study was laid out in a completely randomized block design with three replications. Approximately, fourteen kg of air-dried sandy loam soil was washed with distilled water before added to each plastic pot. Two seedlings of BRRI dhan87 were transplanted to each pot. There were five treatments as follows: T_1= NPKSZn, T_2= T_1 + CuNiSeSi, T_3= T_1 + CuNiSi, T_4= T_1 + CuSi and T_5= T_1 + Si. All treatments received a blanket dose of chemical fertilizer i.e. N-P-K-S-Zn @ 120-15-60-10-1.5 kg ha^{-1}. Cu-Ni-Se-Si @ 1%-0.2%-10ppm-2% as foliar spray was done according to treatments. Plant height, panicle per hill and panicle length did not differ significantly with the applied treatments. However, the filled and unfilled grain per panicle were significantly influenced with the imposed treatments. The maximum number of filled grain per panicle (137) and grain weight (28.79 g per pot) was obtained in T_2 where, Cu, Ni, Si and Se were sprayed in combination with recommended chemical fertilizer. Application of Cu and Si along with recommended fertilizer significantly reduced grain weight and the lowest grain weight 18.48 g per pot was obtained in this treatment.	Determination of micronutrient some selected paddy soils of Bangladesh
Expt.1.9. Nutrient management under conservation agriculture (CA) in double rice cropping system The study was initiated at Paba Rajshahi, in Boro 2018-19 with the objectives to determine the nutrient requirement of rice in Boro-Fallow-T. Aman cropping pattern and to improve soil health under conservation agriculture practices. Two crop establishment methods (unpuddled and puddled) in main plot, two residue management (straw retained and straw removed) in sub plot and four fertilizer doses as recommended fertilizer (RD) 100%, 125% of RD, 75% of RD, and 50% of RD were assigned in split-split plot design with three replications. In Boro 2018-19, puddled and unpuddled rice cultivation produced similar amount of grain yield at each level of fertilizer application. Recommended (100% RD) fertilizer is enough to produce the highest grain yield in puddled rice, while 125% of RD was required for the highest yield under unpuddled condition. In T. Aman 2019, puddled and unpuddled rice cultivation produced similar amount of grain at 100% RD fertilizer application.	Develop tools for sustainable nutrient management of north west Bangladesh

Project 2: Nutritional Problems in Soils	
Expt.2. 1. Long term effect of organic and inorganic nutrients on yield and yield trend of lowland A long-term experiment was initiated on a permanent layout at BRRI HQ farm Gazipur in 1985 Boro season having 12 treatments assigned in RCB design with four replications. The objective of the study was to find the impact of long- term nutrient management on grain yield and soil health. The treatments were revised according to needs (see BRRI, 2016 and BRRI, 2019). The STB doses of NPKSZn were 140-12-80-5-2 kg ha^{-1} and 100-10-80-5-2 kg ha^{-1} for Boro and T. Aman, respectively. In the T. Aman and Boro seasons, omission of N, P, and K decreased rice grain yield compared to complete fertilizer treatment and straw yield was higher in all organic + IPNS treatments. In the T. Aman, among the applied organic materials, CD+IPNS (5.25 t ha^{-1}) and VC + IPNS (5.20 t ha^{-1}) treated plots were produced higher grain yield. In the Boro season, the complete fertilizer treatment gave 6.15 t ha^{-1} grain yield, which was decreased due to omission of N, P and K by 3.62, 3.8, and 2.53 t ha^{-1} respectively. The highest grain yield 6.20 tha^{-1} was obtained from PM + IPNS, which was statistical identical with all other tested organic + IPNS and complete chemical fertilizer including Zn and S omitted treatments. Alike T. Aman, there was no significant yield impact found due to application of two K doses (40 and 80 kg ha^{-1}) in complete fertilizer treatment.	Increased yield and soil health maintenance through balanced fertilization
Expt.2. 2. Effect of intensive rice cropping on rice yield under continuous wetland condition Wetland puddled rice culture influences soil properties and yield in the long run. An experiment on continuous wetland rice culture was initiated in 1971 at BRRI, Gazipur and since then it is running. Six fertilizer treatments viz. control (native nutrient), reverse control (NPKSZnCu), NPK, NPKS, NPKSZn and NPKSZnCu has been testing on rice yield and soil health in a rice-rice-rice cropping system. The varieties tested in T. Aus, T. Aman and Boro seasons were BRRI dhan48, BRRIdhan46 and BRRI dhan50, respectively. This was a non-replicated trial.In 2019, annual rice production in control plot was 6.23 t ha^{1}. However, its reversed management (addition of NPKSZnCu fertilizer) resulted in 12.76 t $ha^{-1}yr^{-1}$ grain production, which was close to complete fertilizer treatment (13.43 t $ha^{-1}yr^{-1}$). Results also indicated that additional use of Zn and Cu once in a year with NPKS increased annual grain yield by more than 0.5 t ha^{-1} than NPKS alone.	Increased annual rice production in wet land condition and soil health maintenance through balanced fertilization.
Expt.2.3. Determining critical limit (CL) of soil nutrients Soil Science Division, BRRI worked on determining the critical limit of P, K, S and Zn for rice in 2019-20. For the purpose, BRRI collected 180 soil samples from intensively cropped areas of 3 AEZs (AEZs 18, 19 and 20) based on land type and soil texture to delineation of different nutrients status in calcareous, non-calcareous, piedmont and terrace soils. Soil samples for each of phosphorus, potassium, sulfur and zinc were analyzed and selected for low, medium and highly fertile soils. Twenty topsoil from 20 selected areas were used in one pot trial. Pot trials on response of rice to each of P, K, S and Zn were conducted in completely randomized design (CRD) with two treatments (with and without P, K, S and Zn)	Determination the critical limit of P, K, S and Zn of soil for balanced fertilization of rice

and three replications. BRRI dhan89 was used as the test crop of rice. The study result showed that the estimated value of critical limit of P, K, S and Zn for rice is 8.7 mg kg^{-1}, 0.09meq 100 g $soil^{-1}$, 16.1 mg $kg^{-1}$and 0.70 mg kg^{-1}, respectively.	
Project 3: Integrated nutrient management for intensive rice cropping	
Expt. 3.1. Integrated nutrient management for double and triple rice cropping fo maximizing productivity The experiment was initiated in Boro 2008-09 at BRRI HQ farm Gazipur in a clay loam soil to find the suitable fertilizer management for double and triple rice cropping system and to find the impact of triple rice cropping on soil health. In Boro-Fallow-T. Aman pattern, BRRI dhan58 and BRRI dhan49 were used. In Boro-T. Aus-T. Aman pattern, BRRI dhan74, BRRI dhan48 and BRRI dhan46 were included as test variety. Fertilizers used were: control, STB dose (NPKS @ 160-25-60-20 kg ha^{-1} for Boro, 70-12-48-10 kg ha^{-1} for T. Aus and 84-15-54-14 kg ha^{-1} for T. Aman), STB (50%) + MM (CD @ 2 t ha^{-1} + ash @ 1 t ha^{-1} (oven dried), FP (NPKS @ 80-10-20-10 kg ha^{-1} for Boro, 70-10-15-0 kg ha^{-1} for T. Aus and 70-10-15-0 kg ha^{-1} for T. Aman). The experiment was laid out in RCB design with three replications. In double and triple rice cropping pattern, 100% STB and 50%STB + MM fertilizer produced significantly high grain yield than Farmers practice (FP) and native nutrient except T. Aus 2019. Cumulative yield of triple cropping was always higher than double rice cropping pattern irrespective of treatments	Sustainable soil health and productivity ensured by nutrient and cropping pattern management.
Expt. 3.2. Performance of vermicompost and poultry manure on rice yield and soil health Study was undertaken with the objectives to find out the effect of PM and VC with chemical fertilizers on yield and yield attributes of T. Aman and Boro rice and its impacts upon soil nutrient status and nutrient uptakes. PM and VC were used with full doses of chemical fertilizer @ 0.5, 1.0, 1.5, 2.0 and 2 t ha^{-1}+ IPNS fertilizer and compared with control. Experimental design was RCB with three replications. Seedlings of BRRI dhan29 and of BRRIdhan49 were transplanted at 20 cm x 20 cm spacing in Boro and T. Aman seasons. Chemical fertilizers (N-P-K-S-Zn @ 138-10-80-5-5kg ha^{-1}) were applied one day before rice transplanting. Integrated use of OM (either PM or VC) and chemical fertilizer significantly stimulated rice yield in both the seasons during the year 2019-20. In the IPNS treatment, application of either VC or PM @ 0.5 t ha^{-1} provided identical grain yield with application of 2 t ha^{-1} of VC or PM during T. Aman and Boro seasons. Among the treatment's VC @ 0.5 t ha^{-1} + full dose of chemical fertilizer showed significantly lower total seasonal CH_4 flux and yield scale CH_4 emission than that of other treatments. In conclusion, Application of 0.5 t ha^{-1} VC or PM with full doses of chemical fertilizer gave potential grain yield and also emitted lower amount of CH_4 in rice cultivation.	Sustainable soil health and productivity through nutrient management.
Project 4: Greenhouse Gas Emission from Rice Field	

Expt. 4.1. Greenhouse gas emissions from rice field Field experiment was conducted at BRRI HQ farm, Gazipur to study the effects of N placement and its sources on rice yield, NUE and emissions of CH_4 gas under continuous standing water (CSW) and alternate wetting and drying (AWD) irrigation regimes. Eight treatments with different N sources IPNS based organic amendments (OA) were tested. PU was applied as broadcast in three equal splits in Boro season and two splits in T. Aman season at 7-10 DAT, while urea briquettes (UB) were applied as a single application during first top dressing (TD) of PU. In the IPNS treatments, poultry litter (PL) and vermicompost (VC) was applied before transplanting. Floodwater samples were collected every day at 8:00 AM before one day of fertilizer application and continued for seven days after each TD of PU to measure floodwater NH_4^+-N using spectrophotometer at 420 µm. The concentration of CH_4 flux in the collected samples were measured using a gas chromatograph (Shimadzu GC-2014, Japan) equipped with a flame ionization detector (FID) and electron capture detector (ECD). Irrespective of water management, deep placed UB significantly increased grain yield compared to broadcast PU at similar N rate in T. Aman while, it showed similar yield in Boro season. UB+IPNS with PL showed higher rice yield compared to broadcasted PU under both irrigation regimes in T. Aman season. While in Boro season, there was no significant variations were observed in rice yield between IPNS and PU treatment Cumulative CH_4 emission was measured from control, UB, PU and PU+IPNS with PL treatments under AWD and CSW conditions during T. Aman season. Control treatments produced significantly lower seasonal CH_4 emission compared to other treatments. Deep placement of UB and IPNS based OA showed similar CH_4 emission in both AWD and CSW conditions. IPNS based OA showed higher seasonal CH_4 emission compared to broadcast PU under both water regimes. On the other hand, AWD irrigation significantly reduced cumulative CH_4 emission compared to CSW irrigation regime within any treatment during T. Aman season.	Quantification of CH_4 emissions and nitrogen use efficiency through fertilizer and water management.
Expt. 4.2. Effect of different organic sources for amelioration of industrial polluted area of Sripur, Gazipur The rice soils of Sripur, Mirzapur and Pirojali were irrigated with contaminated industrial water. Moreover, soils of Mirzapur and Pirojali remain under contaminated water for 5-7 months in a year. A benchmark survey was done with 30 rice soil samples (0-15 cm depth) of that area to know the nutrient status. A number of 3 farmers field experiments were conducted inBoro 2019-20 at each location of Mirzapur and Pirujali and Sripur with the objective to ameliorate such soil with different amendments for rice productivity. Five treatments were as; mixed PGPB inoculum+ chemical fertilizer (CF), biocher 2 t ha^{-1} + CF, Vermicompost 3 t ha^{-1} + IPNS, CF and control. Chemical fertilizer dose was N-P-K-S kg ha^{-1} @100-20-80-10 and treatments were laid out in RCB design. There was no significant positive effect found on grain yield of rice due to application of biochar, vermicompost and PGPB inoculum over chemical fertilizer in the soils of Sripur, and Pirujali. However, significant negative effect of vermicompost found in Mirzapur site. The studied soils contained high organic matter and after 45 days of	Amelioration of industrial polluted area by different organic sources will be developed

transplanting severe Fe toxicity appeared in rice plant.	
Expt. 4.3. Effect of biochar on rice yield in charland soil The study was conducted at BRRI RS, Sirajganj with the objective to improve rice yield by application of biochar. Four treatments (control, recommended fertilizer (RF), RF + biochar @ 2 t ha^{-1}, and RF + biochar @ 4 t ha^{-1}) were laid out in RCB design with 3 replications. The biochar was produced from chitadhan (unfilled grain). The recommended doses of NPKS were 100-15-40-10 kg ha^{-1} in T. Aman and 138-21-75-18 kg ha^{-1} in Boro season. Biochar was applied at the time of final land preparation. Combined application of chemical fertilizer and biochar showed positive impact on growth and yield of rice in T. Aman season. In this season, among the two rates of biochar, application of biochar @ 4 t ha^{-1} with recommended fertilizer dose gave 1.4 t ha^{-1} yield benefit over chemical fertilizer in BRRI dhan87. However, the effect of Biochar was not significant in Boroseason over chemical fertilizer.	Increasing rice yield in charland through biochar management
Project 5: Soil Microbiology and Biofertilizer	
Expt. 5.1. Evaluation of bio-organic fertilizer for the improvement of rice yield and soil health BRRI bio-organic fertilizer was developed with the objectives to reduce synthetic N and P fertilizer use in rice cultivation and improve soil health. To evaluate its field performance, 2 field experiments were conducted at each farm of BRRI HQ and BRRI RS Cumilla in both the season of T. Aman 2019, and Boro 2019-20. Bio-organic fertilizer (BoF) was used at 2 t ha^{-1}. The treatment combinations for BRRI Gazipur was NPKS (100%), BoF + 70% (N) +100% (KS), BoF +100% NPKS and fertilizer control. At BRRI Cumilla, treatments were as; BoF, NPKS (100%), BoF + N (70%) + KS (100%), N (70%) + PKS (100%), NPKZnS (100%) and control. Recommendation rates of chemical fertilizers for Aman and Boro were (N-P-K-S) kg ha^{-1}@ 67-10-41-10 and 140-20-80-10, respectively. BRRI dhan87 at T. Aman and BRRI dhan89 was grown in Boro season. In addition, 2 farmers field demonstrations were conducted in saline soil. Bio-organic fertilizer (BoF_1@ 2t ha^{-1}) has potential to supplement 30% N and 100% P requirement for HYV rice at Gazipur and Cumilla soil without sacrificing yield. In the T. Aman, application of bio-organic fertilizer with 100% NKS gave the highest grain yield of 5.3 t ha^{-1} and it was statistically similar with 100% NPKS and 30% reduced N with 100% KS treatment. However, in the Boro season, the highest grain obtained (7.3 t ha^{-1}) in the BoF with 100% NPKS treatment.At Cumilla, bio-organic fertilizer with 30% reduced N and 100% omission of TSP produced statistically similar grain yield (5.22 t ha^{-1}) with full dose of chemical NPK fertilizer and reduced chemical fertilizer in T. Aman season.However, in the Boro season, the highest grain yield (7.41 t ha^{-1}) was obtained from BoF with 30% reduced N and 100% omission of TSP treatment and it was statistical similar with other chemical fertilizer treatments. Bio-organic fertilizer is capable to improve rice yield in saline soil where irrigation (water salinity varied from 0.65-2.53 dS/m with the corresponding soil salinity ranged from 4.59-7.66 dS/m). In Amtali, Barguna site, application of bio-organic fertilizer 2 t ha^{-1} (dry weight basis) along with 30%	Bio-organic fertilizer as a nutrient source in soil plant system soil

reduced urea and 100% removal of TSP fertilizer increased rice yield about 1.56 t ha^{-1} (28.3%) compared to full chemical fertilizer. Whereas, in Dacope, Khulna site, bio-organic fertilizer increased yield 0.5 t/ha (9.6%) compared to balanced chemical fertilizer of BRRI dhan67.	
Expt. 5.2. Microbial characterization of different AEZs soil The study was initiated in the year of 2019 with the objective to determine the microbial properties of different AEZ soils of Bangladesh. Soil sample collection was started after harvest of Boro 2019-20. A total 40 soil samples were collected (0-20 cm) from each AEZ using GPS and analyzed for total and beneficial bacteria, fungus and actinomycetes. Microbial populations were determined using spread plate count technique with specific growth media. In the first phase, soil samples were collected from AEZ19, AEZ8 and AEZ21. In general, microbial populations were found low compared to any other healthy agricultural soil and among the tested three AEZs soil, comparatively higher number of microbial population were found in AEZ19 and lower in the AEZ8 soil. In AEZ19, soil samples were collected from Burichang and Debidwar union of Cumilla district. In this AEZ, average population (log_{10}cfu g^{-1} soil) of total bacteria, fungus, actinomycetes, free living N_2 fixing bacteria, rhizobium and phosphate solubilizing bacteria (PSB) were 5.8, 4.3, 3.5, 5.8, 5.4 and 5.0, respectively. AEZ21 and AEZ8 were under Kishoreganj district. In the AEZ21 (Karimganj, Sutarpara union), the average population (log_{10}cfu g-1 soil) of total bacteria, fungus, actinomycetes, free living N_2 fixing bacteria, rhizobium, and PSB were 5.8, 3.7, 3.4, 5.8, 5.8 and 5.6, respectively. In the AEZ8 (Bazitpur, Uttar Pirijpur union), average population (log_{10}cfu g-1 soil) of total bacteria, fungus, actinomycetes, free living N_2 fixing bacteria, rhizobium, and PSB were 5.3, 3.9, 3.4, 4.7, 4.7 and 5.3, respectively	Characterization of plant growth promoting bacteria to develop bio-fertilizer

Irrigation and water management

Table-2
Research Progress 2019-2020

Sl.	Research Progress	Expected Output
Sub-Program: Water Management		
Sub-Sub-Program I: Water Use Efficiency Improvement in Irrigated Agriculture		
01	*Water Requirement Experiments:*	
1.1	**Determination of physical and hydraulic properties in different soil types** **Progress:** The study was conducted in BRRI Kushtia Regional Station Farm, BRRI Rangpur Regional Station Farm and BRRI Sirajganj Regional Station Farm. Soil samples were collected from different soil profile at 0-15, 15-30, 30-45, 45-60 cm using standard protocols. In total, 80 samples, 24 samples and 62 samples were collected from BRRI Kushtia, BRRI Rangpur and BRRI Sirajganj, respectively. GPS coordinates were recorded for all soil sample collection points. The soil textural class information along with sand, silt and clay percentages were documented. Irrespective of depths, the general	Documentation of important soil physical properties can help for implementing efficient water management and can contribute to data bank generation for crop modeling

Sl.	Research Progress	Expected Output
	textural class of Kushtia farm was clay, when it was loam to silty loam in Sirajganj farm and mostly loam in Rangpur farm. The average soil bulk density considering all depths, Kushtia farm had a bulk density of 1.46 gm/cc, Sirajganj farm had bulk density of 1.33 gm/cc and Rangpur farm had bulk density of 1.30 gm/cc. The soil water release curves of all depths in each sampling points were constructed. The infiltration experiments both in Kushtia farm and Sirajganj farm showed that final infiltration rate was higher in Kushtia farm and it was 24 mm/hr. On the other way, Sirajganj farm infiltration rate was comparatively low, and it was 2 mm/hr. However, the final or constant infiltration rates were calculated from field observed data and did not fitted with any infiltration equation**.**	
1.2	**Automated Alternate Wetting and Drying Irrigation System for Rice Production** **Progress:** The study currently ongoing in collaboration with Department of Computer Science and Engineering, United International University (UIU), Bangladesh. A sensor-based technique has been adopted for applying water efficiently and properly in AWD irrigation system. The Arduino pro mini and Arduino UNO as processing power, sonar sensor for measuring the water level and RF module for communication between field monitoring device and the base station (pump turning on/off) are the components of the automated irrigation system. In Boro 2019-20 season, the automated system containing a base station, field tubes with transmitting section to base station and an internet modem to transmit data to sever was installed in BRRI Gazipur farm. The base station with internet modem was setup in the pump house near the IWM research field. Four field tubes (AWD pvc pipe) were setup in four plots after transplanting. The transmitter module was placed on top of each field tube. A monitoring app was developed by CSE department, UIU to get update about the water level in the field tubes remotely. A small solar panel would be connected instead of rechargeable batteries to supply power so that the whole unit could be placed with a clamp on top of the field tube. The modification of the system and testing have been in progress in CSE department lab.	The outcomes from this study are expected to reduce irrigation cost by 30%, to increase water productivity and to reduce labor involvement in rice irrigation as well as introducing of digitalization in irrigation system in Bangladesh.
1.3	**Problem and potentials for crop productivity improvement through water management in hilly areas** **Progress:** In the year 2019-2020, the study was conducted in Rajastali Upazilla of Rangamati district. A field visit and detailed survey was conducted in that region. Five locations, based on water resources availability sources for irrigation purpose, were physically assessed extensively. The water sources are basically small hill creeks, locally known as “Chara”. As mentioned earlier, Pine Chora-1, Pine Chora-2, Boga Chora, Kudum Chara and Bangalhalia Chora were visited. It was found from physical assessment and group discussion that the main source of irrigation water used in agriculture section was the small hill creeks or fountains. These water spots are locally known as “Jiri’ or “Chora”. Usually the water was conserved in the canal by constructing cross dams and applied to the agricultural field through gravity	The possible outcomes of this study would be the identification of water resources suitable for agricultural use in the area and then suggesting recommendation of options for utilization of water resources in agricultural development.

Sl.	Research Progress	Expected Output
	channel. If a pipe distribution networking could be built in each command area of a water source, it might increase the potential utilization of water sources in agriculture. The study in the respected area reveled that if cross dams across the creeks and fountains along with a proper water distribution system (pipe distribution networks) in the command area could possibly increase the agricultural land area coverage to 50 hectares.	
1.4	**Study on water stress tolerance for different advanced rice genotype of BRRI** **Progress:** Grain yield were statistically significant difference by genotype and water stress during Boro season 2019-20. There were two ALART named BR(Bio)11447-1-28-14-3 and BR(Bio)11447-3-10-7-1 along with standard and susceptible check BRRI dhan28 supplied from Biotechnology Division. ALART BR(Bio)11447-1-28-14-3 and BR(Bio)11447-3-10-7-1 has the water stress tolerance capacity of -10 kPa and -30 kPa, respectively. ALART BR(Bio)11447-3-10-7-1 gave higher yield than ALART BR(Bio)11447-1-28-14-3 and check variety up to -10 kPa and -30 kPa. ALART BR8938-19-4-3-1-1-P2-HR3 and BR9651-15-2-1-4 were tested under ALART-1, disease resistance and BB along with BRRI dhan28 and BRRI dhan58 as susceptible and standard check, respectfully. ALART BR8938-19-4-3-1-1-P2-HR3 has water stress tolerance capacity upto -10 kPa. ALART BR9651-15-2-1-4 gave higher yield up to -60 kPa water stress compared to continuous standing water. ALART HR(Path)-11, Path 2441 and BR(Path)12452-BC3-16-19 were tested along with standard check BRRI dhan58 and BRRI dhan29 under ALART-2, disease resistant, Blast. All the ALART has water stress tolerance capacity up to -30 kPa. BRRI dhan29 gave higher yield up to -10 kPa water stress compared to other two ALART and BRRI dhan58.	The outcomes of this study would provide information regarding scaling of water-stress tolerance capacity (WSTC) of each variety, easy scheduling of irrigation based on WSTC, and additional information for cultivation of a newly released variety
1.5	**Determining Minimum Irrigation Water Requirement of Rice at Different Regions of Bangladesh through Water Balance from On-Farm Demand and Model Simulation** **Progress:** Field experiments were established with four treatments and three replications. The experiments of Boro 2019-20 were conducted in Kushtia and Ragnpur regional stations. The experimental design will be RCBD. PVC pipe of 25 cm height was placed in different plots to observe the water level. Evaporation pan and field lysimeter were used to measure evaporation and seepage & percolation, respectively, in the field. One available water balance model, CROPWAT was used for simulation purpose. Water requirement was simulated using long-term (30–50 years) normalized rainfall data. Boro experiments were completed, result analysis is ongoing. Aus experiments are in the field right now at ripening stage. T. Aman experiments will be established in Kushtia, Rangpur and Gazipur stations.	The expected outcomes of this study will fulfill the gap between simulated and on-farm demand-based water requirements. It will determine the possible minimum water requirement for rice irrigation for different regions. It will also help to increase water productivity and field water-use efficiency
1.6	**Optimization of irrigation water use for Boro cultivation under different establishment methods** **Progress:** The experiment was conducted at BRRI HQ farm, Gazipur	Suitable cultivation and water management practice

Sl.	Research Progress	Expected Output
	to find out a suitable method of Boro cultivation under water limiting conditions. Nine experimental treatments were: T1- Transplanting with maintaining continuous standing water (TP-CSW); T2- Transplanting with AWD (TP-AWD); T3- Transplanting with thin irrigation practice (TP-TI); T4- Dry direct seeding with maintaining continuous standing water (DS-CSW); T5- Dry direct seeding with AWD (DS-AWD); T6- Dry direct seeding with thin irrigation practice (DS-TI); T7- Wet direct seeding with maintaining continuous standing water (WS-CSW), T8- Wet direct seeding with AWD (WS-AWD) and T9- Wet direct seeding thin irrigation practice (WS-TI). Under WS rice, sprouted seeds were places with a Drum Seeder on the puddled soil with spacing 18 cm. BRRI recommended fertilizer doses were used. Performance of irrigation scheduling treatments (CSW, AWD, TI) varied differently according to the rice establishment methods (TP, DS, WS). Irrespective of establishment method, shifting to AWD and TI practice from CSW practice saves irrigation water significantly. On the other hand, shifting from transplanting to dry direct seeding (DS) establishment method saves irrigation water significantly. Wet direct seeding with drum seeder can give higher yield with less amount of irrigation. The experimental results show that good yield could be achieved with both dry direct seeding and wet direct seeding.	for Boro rice under water and labour scarce condition. will be optimized.
1.7	**Performance evaluation of the proposed rice varieties under different water regimes** **Progress:** The study was conducted to find out suitable water regimes for rice varieties and proposed lines. BRRI dhan29, BRRI dhan89 and BRRI dhan92 were grown under four water regimes as: T1 = Maintaining continuous standing water (CSW) from 1 to 5 cm; T2 = AWD irrigation practice (+5 to -15 cm); T3 = Aerobic condition (AWD: 0–25 cm) up to booting stage; and T4 = Aerobic condition (AWD: 0–25 cm) during the entire crop period. BRRI dhan89 have tolerance to non-ponding condition. Good yield could be achieved with maintaining CSW practice. AWD practice gave good yield for BRRI dhan92. BRRI dhan89 gave similar yield for both AWD practice and aerobic conditions.	The outcomes will provide guidelines for selecting irrigation water saving rice variety and water management package identification for specific variety.
Sub- Sub Program II: Utilization of Water Resources in Rainfed Environment		
02	*Water Management for rice cultivation in climate change environment Experiments:*	
2.1	**Agricultural drought forecasting for mitigating drought in T. Aman rice** **Progress:** The experiment was conducted at BRRI farm Gazipur in T. Aman 2019. BRRI dhan49 was used as test variety. Weather Research and Forecasting (WRF) model was used to forecast 7 days daily minimum and maximum temperature, average relative humidity (%), wind speed. Forecasted rainfall and evapotranspiration were used as input of Drought Simulation Model (DS model) (Towfiq, 2007) to quantify agricultural drought. CROPWAT 8.0 was used to compare the quantified drought. Thirty days old seedlings were transplanted on 3 August 2019 and harvested at 14 November 2019. Enough rainfall occurred during the T. Aman season 2019 and no drought occurred. A good matching was found between observed and forecasted rainfall.	The outcomes will provide a good drought forecasting system, drought quantification in terms of frequency, period and severity, amount and number of supplemental irrigations for mitigating drought Impact of drought on yield, and

Sl.	Research Progress	Expected Output
	Yield parameters showed that there are no significant differences between treatments.	comparative performance of Towfiq's model.
Sub- Sub Program III: Land and Water Resources Use for Sustainable Crop Production		
03	*Land and Water Resources Use for Sustainable Crop Production Experiments:*	
3.1	**Water resources assessment for dry season crop cultivation in selected polders of coastal region** **Progress:** The study was conducted in polder number 30 and 31 situated at Botiaghata and Dacope, Khulna. In polder 30, total good, poor, and bad canals were found 136, 38 and 80 km long respectively. About 190, 101, 76 km good, poor, and bad canals were recorded in polder 31. Total stored water during April were estimated 334 ha-m and 502 ha-m, respectively. Considering 30%, 50% and 100% excavation of poor and bad canals the water storage was increased to 440, 511 and 688 ha-m, respectively in polder 30 and 660, 766 and 1030 ha-m, respectively in Polder 31. At present condition, 334 ha and 502 ha area can be brought under cultivation in polder 30 and 31, respectively if all the fresh water in canals trapped in December. Considering, 30%, 50% and 100% canal excavation, Boro area could be increased to 440, 511 and 688 ha, respectively in polder 30 and 660, 766 and 1030 ha, respectively, in Polder 31.	The outcome will evaluate the availability of suitable water in terms of salinity for irrigation at different distances from the coast towards the upstream and provide guidelines for productivity improvement through assessment of available suitable water resources for irrigation
3.2	**Boro area expansion by using less saline water resources for cropping intensification in Barisal Region** **Progress:** A total of 82 hectares of fellow lands through 21 block demonstrations were brought under Boro cultivation using surface water from nearby canals in six upazilas of Barisal region. Under these blocks, a total of 286 beneficiary farmers were directly involved. Farmers were supplied 20 low lift pump (LLP) sets and flexible pipes. Transplanting of Boro rice in this region was late mainly due to late harvesting of Aman rice. Averaged across all locations, yield of BRRI dhan47, BRRI dhan57, BRRI dhan67, BRRI dhan74, and BRRI dhan89 ranged from 5.5 to 6.2, 5.3 to 6.2, 5.4 to 6.1, 5.7 to 7.1, 6.4 to 7.5 t/ha, respectively. More than 500 tons of rice grains were harvested under the demonstration program that eventually increased the crop productivity in this region. Most of the farmers gave their preferences on BRRI dhan47 and BRRI dhan74. There is suitable irrigation water available during the season which can be beneficially used for Boro cultivation. So, farmers are interested to cultivate Boro rice if LLPs are available. Canal network narrowed for sedimentation needed to be re-excavated.	The study will provide information for Increasing cropping intensity of the area by expanding Boro cultivation using less saline surface water from river.
Sub- Sub Program IV: Sustainable Management of Groundwater		
04	*Surface and Ground Water Assessment Experiments:*	
4.1	**Assessment of Groundwater resources and safe utilization in different Geo-hydrological regions** **Progress:** Monthly groundwater level fluctuations at Gazipur during 2019-20 showed that maximum lowering of groundwater (44.83 m) was observed in August and minimum (43.75 m) in May. The rainy season started from March and the rising of groundwater observed.	The possible outcomes will determine fluctuation of groundwater level over time and its relationships with rainfall and also,

Sl.	Research Progress	Expected Output
	The declination of groundwater level during 1998-2020 showed that maximum groundwater level at BRRI farm Gazipur is declining day by day and it was not fully recharged after the monsoon. In 1998 the maximum groundwater level was about 11.68 m from the ground surface which was 44.83 m in 2019. So, the lowering was about 33.15 m in 21 years. During the initial five years the lowering rate was not so high, and it was only 3 m (14.6-11.6 m). But during the last five years (2014-2019) the lowering was about 9.6 m which is about more than 3 times of the initial declining rate. So, the present high rate of declination is very alarming. The lowering is due to increased pumping demand due to establishment of many factories and industries surrounding BRRI H/Q.	determine water quality for assessing its suitability for irrigation
4.2	**Assessment of groundwater level depletion dynamics in selected locations of Bangladesh** **Progress:** This study was conducted in northwest region of Bangladesh aims to evaluate the groundwater fluctuation pattern and to assess the judicial use of groundwater for irrigation. The groundwater level has been analyzed for 16 districts (Fig 9). Among the 108 upazilas, groundwater resources are getting scarce in 44 upazilas. Minimum groundwater level is increasing both in Pabna and Bogura region indicates that recharge amount is decreasing than withdrawal. Farmers are using 38% more water than actual water requirement during Boro season. In Rangpur, on an average 0.2 billion cubic meter (BCM) per year groundwater shortage was faced for last l0 years due to over withdrawal following farmers practice (Fig 3). But average 0.55 BCM per year excess groundwater was estimated following actual irrigation requirement approaches. To balance utilization of groundwater, 60%, 50%, 50%, 100% and 40% of Boro area needed to bring under irrigation based on actual irrigation requirement in Bogura, Pabna, Naogaon, Joypurhat and Rangpur, respectively.	The study outcomes will provide information on withdrawal and recharge pattern of groundwater as well as safe groundwater withdrawal level.
Sub- Sub Program V: RENEWABLE ENERGY		
05	*Renewable Energy Experiments:*	
5.1	**Evaluation of smallholder surface water solar irrigation system for crop production** **Progress:** A field experiment at BRRI, Gazipur was conducted prior to setting the solar irrigation systems. The aim of this experiment was to develop a model to simulate the flow rate by using only the solar radiation data. We have collected flow rate and solar radiation data every half an hour interval from dawn to dusk. The flow rates from pump were measured at different solar irradiance intensities. Pyranometer was used to measure solar irradiance of PV array during experiments. We have developed a correlation between solar radiation and flow rate keeping a constant pumping head of 2 m. We have proposed a 2nd degree polynomial model which allows us to	The expected outputs would be: minimum number of solar panels required for smallholder irrigation, easily movable trolley or portable type PV panel structure will be obtained,

Sl.	Research Progress	Expected Output
	contribute in the studies of photovoltaic (PV) water pumping system. The site-specific long term global horizontal irradiance (GHI), direct normal irradiance (DNI) and diffuse horizontal irradiance (DHI) data were collected from the Global Solar Atlas. The highest discharge was found for Pirojpur Sadar upazila in March and the lowest discharge was found in May at Bakerganj upazila of Barishal district. The highest monthly average daily simulated discharge (232 m3/day) was found in the month of March at Sadar and Nazirpur Upazillas of Pirojpur district and the lowest discharge was 171 m3/day in the month of May at Bakerganj Upazilla of Barisal district.	maximum discharge in terms of suction head will be identified, maximum command area will be determined by using the solar water pump for rice irrigation, and feasibility of the solar pump for rice cultivation will be known.
Sub-Sub Program VI: Water Management Technologies Demonstration and Dissemination at Farmers' Field		
06	*Technology Validation in the Farmers' Field Projects:*	
6.1	**Cropping systems intensification in the salt-affected coastal zones of Bangladesh and West Bengal, India (November 2015 to June 2020)** **Progress:** The ACIAR Australia and KGF, Bangladesh jointly funded project has been conducted in Polder #43/1 at Amtali, Barguna (medium salinity area) and Polder #31 at Dacope, Khulna (high salinity area). **Selection of suitable T. Aman rice varieties for facilitating Rabi crops intensification.** The experiment was setup in a RCBD at Dacope, Khulna and Amtali, Barguna to find out the suitable varieties for improving the facility for timely sowing of Rabi crops and to improve the land and water productivity with rice varieties were BR23, BRRI dhan49, BRRI dhan71, BRRI dhan75, BRRI dhan76, BRRI dhan77 and BRRI dhan87 along with the popular local varieties. In Dacope area, BRRI dhan87 produced the highest grain yield (5.4 t/ha) followed by BR23, BRRI dhan77 and BRRI dhan76 and most of the farmers of that locality showed their interest to cultivate BRRI dhan87, BRRI dhan77, BRRI dhan76 and BR23 in next T. Aman season. In Amtali area, BRRI dhan76 produced the highest grain yield (5.6 t/ha) followed by BRRI dhan77 and BR23 and most of the farmers showed their interest to grow. **Performance of Boro rice under water saving conditions in saline areas.** The study was conducted at Dacope, Khulna and Amtali, Barguna during the dry season of 2019-20. Due to the lower salinity (within then permissible limit of 4 dS/m) of canal water and rice field water in both the locations, there was no significant variation in rice yield in different water management systems, i.e. continuous standing water (CSW) and alternate wetting and drying (AWD). But there was a significant variation in rice yield was found in different tested locations and among the varieties. The lowest yield of BRRI dhan67 was found in both the locations. Due to the varietal potentiality, BRRI	The possible outcomes will be used for boosting up the livelihood of the people of salt-affected coastal zone.

Sl.	Research Progress	Expected Output
	dhan89 gave the higher yield in both the locations. This may be happened due to the comparatively lower salinity during the rice production season. **Evaluation of different mulching materials in rice under saline areas.** The study was conducted at Dacope, Khulna and Amtali, Barguna during the dry season of 2019-20. The experiment involved five mulching treatments viz. No mulch, mulching with ash, mulching with saw dust, mulching with rich husk, and mulching with rich straw. The highest grain yield was found in ash mulching and the lowest grain yield was found in saw dust mulching in both the locations. Ash mulching treatment produced comparatively higher yield in both the locations. It may be happened due to higher potassium content in ash, which reduced the salinity effect from rice field. Ash mulching showed 1.28 to 3.03% yield advantage over the conventional no mulching treatment at Dacope. **Block demonstration of Boro rice by using canal water.** The experiment was setup in a RCBD at Dacope, Khulna and Amtali, Barguna with BRRI dhan67, BRRI dhan74, and BRRI dhan89. In Dacope area, all the tested varieties produced the highest grain yield compared to Amtali area. The yield in Dacope area varied from 5.80 to 6.34 t/ha with an average of 5.82 t/ha, whereas in Amtali area rice yield varied from 5.52 to 5.84 t/ha with an average of 5.70 t/ha. Salt tolerant BRRI dhan67 performed well in both the sites. Fresh water availability is the main constraints for Boro cultivation. However, farmers are interested to grow Boro rice by trapped canal water. **Planting time for Aus rice cultivation in saline areas.** The study was conducted at Dacope, Khulna and Amtali, Barguna during the dry season of 2019-20. The trapped canal water was used for irrigation for seedling raising and sometimes for crop establishment. Among the seven sowing dates, 10 April to 30 April sowing date performed better irrespective of all tested varieties and locations. The average yield of the optimum window of sowing for both the tested varieties were above 4.5 t/ha in both the locations. After that, the yield performance declined due to high soil salinity for lacking fresh water. **Performance of Aus rice for crop intensification in coastal zones.** The experiment was setup in a RCBD at Dacope, Khulna and Amtali, Barguna with BRRI dhan48, BRRI dhan67 and BRRI dhan82. In both the locations, BRRI dhan48 performed best. In Dacope area, rice yield varied from 4.09 to 4.47 t/ha with an average of 4.16 t/ha and in Amtali area it varied from 3.92 to 4.30 t/ha, with an average of 4.11 t/ha. Both the locations, farmers faced troubles in seedling raising of Aus rice due to freshwater shortage and high soil salinity. **Climatic variability and crop production options for cropping intensification in the coastal Bangladesh.** Long-term rainfall (1981-2018) were analyzed for the research area Dacope, Khulna and Amtali, Barguna. Dry season rainfall of 10 mm was considered as heavy rainfall and rainfall of 20 mm was consider as very heavy rainfall (SMRC, 2008). Long-term rainfall (2001-18) frequency analysis	

Sl.	Research Progress	Expected Output
	showed that in both the locations was above 40% for very heavy rainfall and that was above 90% for heavy rainfall. On the other hand, return period of those rainfall during the non-rice crop growing period was very frequent. In every 1.5 to 2.0 years, in both the locations, Rabi crops establishment were delayed due to heavy rainfall. Similarly, in every 1.5 to 2.0 years, Rabi crops were partially or fully damaged due to rainfall waterlogging in both the locations. In contrast, heavy to very heavy rainfall can enhance rice production and soil salinity reduction.	
6.2	**Groundwater resource management for sustainable crop production in northwest hydrological region of Bangladesh (1 February 2018 to 30 June 2021)** **Progress:** The NATP Phase-2 funded project has been running in Rangpur and Pabna region. **Study on groundwater availability assessment and its utilization.** This study was done to analyze ground water table of Rangpur and Pabna districts of northwest region and to determine groundwater withdrawal level for retarding water table declining using TI model, a conceptual GWT model. Analysis results showed that range of maximum and minimum GWT depth are from 9.95 m to 6.92 m and from 6.1 m to 1.0 m respectively at Iswardi. Average withdrawal depth i.e. difference between minimum and maximum GWT depth is also the highest (6.20 m) at Iswardi. The TI model revealed that 56.22 percent area should cover under AWD irrigation for next 5 years to bring ground water table withing suction limit and it should be disseminated in 28.1% area for 10 years to bring the GWL within the desired limit. **Determination of less irrigation required cropping pattern for water scarcity area.** This study was executed to identify the irrigation efficient cropping pattern in the water scarce area of Bangladesh using five cropping patterns in Mithapukur and Pirgonj of Rangpur and Ishwardi and Santhia of Pabna. T. Aman-Potato-Boro cropping pattern gave the highest rice equivalent yield (REY) ranged between 21.9-30.4 t/ha at Mithapukur, Pirgongj and Santhia sites. Lentil-T.Aus-T.Aman cropping pattern gave the maximum REY at Ishwardi site. Boro-Fallow-T. Aman cropping gave lowest REY in all the locations ranges between 12.3-12.8 t/ha. The highest irrigation water productivity 3.5 kg/m^3 was found for Lentil-T. Aus-T. Aman cropping pattern followed by 3.3 kg/m^3 for Potato-Boro-T. Aman cropping pattern.	The expected outcomes will help to manage groundwater utilization efficiently and economically.

Plant Pathology

Table-2
Research Progress 2019-20

Sl No.	Research Progress	Expected output
1	Survey and monitoring of rice diseases	Survey was done during maximum tillering and onward in T. aman and Boro season. Sheath blight was predominant in T.Aman while blast was in Boro.
2	Isolation, Purification, Confirmation and Inoculation of rice false smut pathogen (*Ustilaginoidea virens*)	The conditions for successful isolation of *Ustilaginoidea virens* (False smut) in axenic cultures have been standardized and the growth conditions were optimized. Morphological identification, the identity of the fungal pathogen was confirmed through ITS sequencing (>1st_BASE_3656919_A1_ITS_4) which showed up to 98 % identity with *U. virens* in NCBI-BLAST analysis.
3	Identification of physiological races of bacterial blight and its distribution patterns (NATP-2)	300 bacterial blight isolates were isolated & preserved. Among the isolates, 10 physiological races were identified based on the reaction pattern against BB resistant NILs.
4	Improvement of differential system for rice blast disease in Bangladesh	The reaction pattern of single spore isolates were similar to the last year pattern. It indicated that this year, no new differential isolates were included in the existing differential system.
5	Development of a new disease rating scale for sheath rot disease scoring	A standard evaluation system for sheath rot disease scoring has been initially developed based on three criteria of sheath rot disease such as lesion length, panicle exertion length, and % sterility of sheath rot disease infected rice panicles.
6	Development of an effective inoculation technique for mass screening of sheath rot disease of rice	The study of development of an effective inoculation technique for sheath rot disease screening showed injection and wrapping with mycelium plug as the best methods for 100% disease development under artificial inoculation condition
7	Pathogenic variability of *R. solani*	Pathogenic variability of *R. solani* was done using the primer ITS1 and ITS4. Further evaluation will be done although no difference was observed among the tested isolates.
8	Molecular identification of seedling blight causing fungi	*Fusarium equiseti* was identified as one of the rice seedling blight causing fungi through ITS sequencing.
9	Estimation of yield loss due to sheath rot disease in rice	The estimation of yield loss due to sheath rot disease revealed that the trend of increasing every unit of each disease severity (DS) scale, the weight of filled grains decreasing 0.27 g/panicle.
10	Estimation of yield loss due to blast disease in rice	On an average 24% yield loss was calculated due to blast disease.
11	Estimation of yield loss due to sheath blight disease in rice	On an average 18% yield loss was calculated for sheath blight disease.

Sl No.	Research Progress	Expected output
12	Evaluation of Bacterial Community in Rice field of Kansai region, Japan	*Chloroflexi, Acidobacteria, Proteobacteria, Actinobacteria, Planctomycetes* were the dominant phyla of rice soil from 16S amplicon sequencing (Illumina MiSeq 250bp in Kansai region. The phylum *Kazan-3B-28* was found more in organic system than conventional. The bacterial community was more affected by location and soil type than by management systems.
13	Improvement of BRRI dhan28 and BRRI dhan58 for resistance to blast and bacterial blight diseases using marker assisted backcross breeding	In Boro season, seven backcrosses and a single intercross were made to obtain seeds of advanced generation. (Table 2 and Table 3). Heterozygosity of the populations was confirmed through respective marker.
14	Pyramiding of Bacterial Blight and Blast Resistance Genes into the Genetic Background of BRRI dhan29 (BAS project)	In Aman'19 four backcrosses were made to obtain BC3F1 seeds whereas in Boro season four selfing were made to obtain BB and blast resistant genes among the parents. Heterozygosity of the populations was confirmed through respective marker. After confirmation crossing was done to make next generation.
15	Gene Pyramiding of Bacterial Blight Resistance Genes into the Genetic Background of BRRI dhan49, BRRI dhan63 & BRRI dhan81 (NATP-2)	In Aman'19 six backcrosses were made to obtain BC2F1 seeds whereas in Boro season, six backcrosses were also made among the parents to obtain BC3F1 population (Table 6 and Table 7). Heterozygosity of the populations was confirmed through respective molecular marker. After confirmation, crossing was advanced to make next generation.
16	Gene pyramiding for bacterial blight (BB) resistance (BAS project)	Phenotyping and genotyping were applied for suitable plant selection. Pathogenicity results showed that a good number of progenies of BC4F1, BC3F1 and BC3F3 developed from the crosses were resistant to the most virulent BB isolate BXO93.
17	Screening of rice germplasm against bacterial blight (BB) disease (NATP-2)	A total of 350 rice germplasm along with checks were screened against bacterial blight pathogen. Among the 350 tested germplasm, 14 entries found resistant.
18	Confirmation of resistant genes of Bacterial Blight resistance through gene base SSR markers through and pathogenicity test	Out of 78 germplasms, Three germplasm (Acc. No.: 4216 & 7370) contain 3 resistant genes (Xa4, xa5 and xa13/Xa21), 21 germplasm contain 2 resistant genes (Xa4 and xa5/ xa13/Xa21) and others have single or no resistant gene.
19	Development of partial resistant pre-breeding materials for blast disease.	Out of 94 individuals, 71 had homozygous allele for *Pi9, Pb1* and *pi21* gene; 17 had homozygous allele for *Pi9* and *Pb1* gene and 6 had homozygous allele for *Pi9* and *pi21* gene.
20	Introgression of Blast resistant genes into BRRI dhan47	A total of 68 homozygous (BC3F5) plants with *Pi40* gene (confirmed by RM547) were selected for RGA trial.
21	Development of pre-breeding materials of tungro resistance	In Aman'19 nine crosses and in Boro season'2019-20 nine crosses were made. Heterozygosity of the population was confirmed by using molecular marker.
22	Linkage and QTL mapping of tungro resistance in rice (KGF	Mapping of QTL in tungro resistant Kumragoir, hybridization was done between Kumragoir and BRRI

Sl No.	Research Progress	Expected output
	Project)	dhan48 to produce mapping generation. Genotyping was done through 98 polymorphic markers in 384 plants of BC2F2 population.
23	Screening of rice genotypes against rice tungro disease	Among thirty-nine genotypes, 9 were resistant, 9 were moderately resistant and 21 were found susceptible.
24	Introgression of *Pi9* or *Pita2* gene in BRRI dhan29/BRRI dhan63 (KGF Project)	Different back cross generations of BRRI dhan29-Pi9 (BC1F4, BC2F3, BC3F3) and BRRI dhan63-Pita2 (BC6F4, BC5F5, BC4F6, BC3F7) were selected.
25	Pyramiding blast resistant *Pita2* and *Pi9* genes into Boro varieties (KGF Project)	Introgression of both leaf blast resistant *Pita2* and leaf as well as panicle blast resistant *Pi9* genes were introgressed in the background of BRRI dhan28, BRRI dhan29, BRRI dhan63. BC2F1 seeds of BRRI dhan28, BC1F1 seeds of BRRI dhan29 and BRRI dhan63 were harvested for further advancement.
26	Linkage and QTL mapping of BR16	F1 seeds were produced by hybridization between BR16 and a universal blast susceptible variety US2 in T. Aman 2019. Further BC1F1 seeds were produced through back crossing with US2
27	Screening of rice germplasm against sheath blight	Among the tested local germplasm, Acc. No. 5056 (20% RLH), Acc no. 499 (25% RLH) and Acc no. 4362 (30% RLH) showed moderate resistance against the sheath blight disease.
28	Screening of advanced breeding lines against bacterial blight (TRB)	A total of 833 advanced breeding lines including OYT, AYT and RYT materials were inoculated with most virulent bacterial blight (BB) isolate during Boro 2019-20 season. Among them 139 materials were found resistant.
29	Development of blast resistant varieties using differential system and molecular Markers	Among the tested 3982 lines (LST), 38 lines were selected as neck blast resistant from Cumilla and 379 lines were selected from Gazipur mostly based on the yield performance.
30	Studies on the genetic mechanism of rice blast and gall midge resistance in BRRI dhan33	A total of 625 markers were surveyed for polymorphism studies between BRRI dhan33 and US2 and 184 markers showed polymorphic. The phenotyping against neck blast disease has completed.
31	Detection of novel loci underlying rice blast and BB resistance by integrating a genome-wide association study and evaluation of resistant genes in the background of 186 local germplasm in Bangladesh	For developing resistant variety, candidate resistant genes *Pi9* for blast and *Xa21* for BB have already identified using differential system in Bangladesh. IRRI has already done rice genome sequence (3K rice genome database) including Bangladeshi 186 germplasm. Data showed that 6.45% germplasm harboured blast resistant Pi9 gene and 18.28% harboured BB resistant *Xa21* gene in their genetic background. In addition, 12 materials were found those harboured both *Pi9* and *Xa21* in their genetic background.
32	Development of Blast Resistance Rice by CRISPR/Cas9-Targeted Mutagenesis of the OsERF922 gene	To design a CRISPR/Cas9 targeting the OsERF922 gene in rice, a 19bp nucleotide sequence (5′-TCTCCTTGGGGTTTAGCGC-3′) was a protospacer adjacent motif lying within the ERF922 coding sequence

Sl No.	Research Progress	Expected output
		(LOC_Os01g54890). The target site was ligated with an intermediate vector SK-gRNA sequence.
33	Screening of advanced breeding line against Sheath blight of rice	Among 40 materials, none of materials showed resistant reaction against the disease.
34	Disease reactions and characterization of upland rice germplasm	A total of 24 upland germplasm was evaluated and four genotypes namely Chirikata 2, IR 5533-50-1-10, IR 9559-PP 871-1, and Ja No Naq were found resistant to moderately resistant against all diseases and gave high yield under natural infection.
35	Screening of INGER materials obtained from IRRI against blast disease of rice, Boro 2019-20.	Among 91 tested materials, 22 entries found as resistant.
36	Screening of advanced breeding lines against blast disease of rice, Boro 2019-20	Among 30 advanced breeding lines, only one line (BR9891-8-2-1-41) showed as resistant.
37	Screening of INGER materials against bacterial blight disease	Among 168 INGER, twenty-nine showed moderately resistant against major BB isolate but no resistant material was found.
38	Screening of advanced breeding lines against bacterial blight (BB) disease during T. Aman19 and Boro 19-20	Out of 54, only one genotypes was found as resistant and 3 materials as moderately resistant in T Aman19. In Boro19-20, Among 37 tested germplasms; two and four materials were found as resistant and moderately resistant, respectively.
39	Evaluation of effective chemical against Sheath Blight disease of rice, T. Aman 2019	Five fungicides namely VAI-Two 35 SC, SR TOP 32.5 SC, Cropstar 32.5 SC, Ulka Plus 35 SC and Admine Top 35 SC of 20 tested fungicides-controlled sheath blight disease successfully (equal or above 80%) in both BRRI Gazipur and Rajshahi Farm.
40	Control of rice seedling blight disease	Among the tested fungicides six fungicides eg., Alix, Azonil. Limostar top, M-zole and Tramp were found effective as like the standard check fungicide Amistar top which produced no infection.
41	Evaluation of new chemicals against Blast disease of rice	A total of 22 new chemicals including trooper (check) were evaluated during Boro season, 2019-20. Among them, only 7 fungicides (mostly Tricyclazole group fungicide) were controlled more than 80% blast disease.
42	Factors affecting rice tungro disease and its management in Cumilla region	GLH population was very low in insecticide sprayed seed bed and main plot compared to control plots. The weather parameters greatly influenced the population of GLH in in rice field. High temperature and low rainfall encouraged the GLH population.
43	Biocontrol of Soil Diseases Associated with Rhizosphere of Rice (*Oryza Sativa* Subsp. *Japonica*) Growing Field in Kansai Region, Japan	For biocontrol, the rhizospheric bacteria were isolated and molecularly identified. The results indicated that DAR17225040 and DAR17225017 were 99% similar to *Bacillus aryabhattai* and *Bacillus megaterium*. The isolated bacteria were able to suppress Bacterial Leaf Blight and Sheath Blight disease 78% and 86%

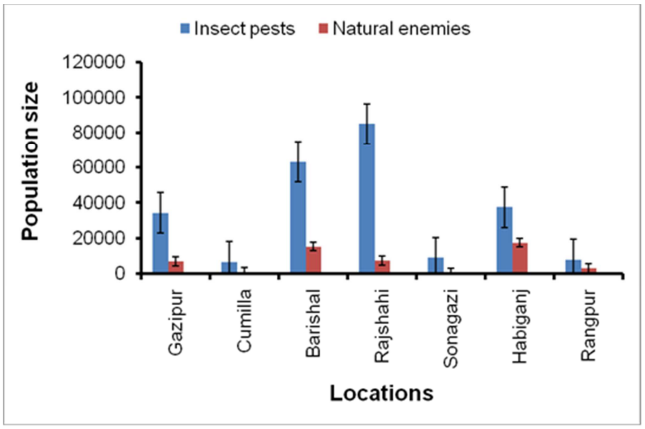
Sl No.	Research Progress	Expected output
		respectively, under greenhouse conditions.

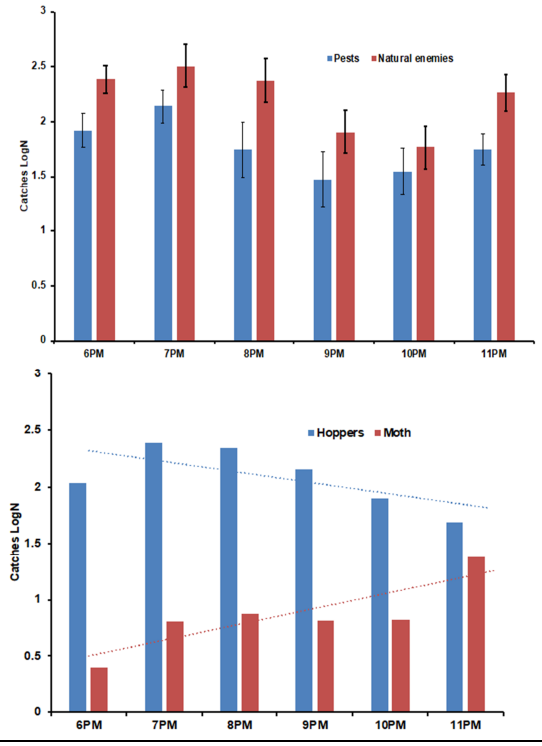
Entomology Division

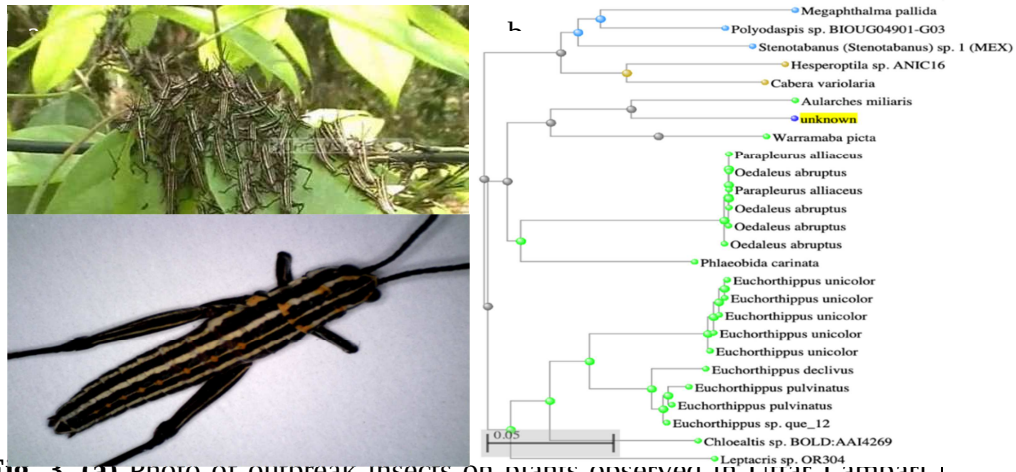
Table 2

Research Progress 2019-2020

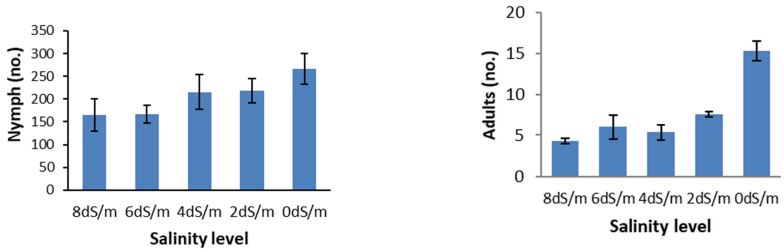
Sl. No	Research Progress Program area/Project (Duration)	Expected output
1	**Project: SURVEY AND MONITORING OF RICE ARTHROPODS** **Expt. 1. Pest and natural enemy incidence at BRRI farm, Gazipur** **Duration:** Long term **Progress:** Rice insect pests, their natural enemies and crop damage intensities in six habitats (seedbed, rice ratoon, grass fallow, irrigated rice, rice bund and upland rice) were monitored weekly by 100 complete sweeps from each habitat at BRRI research farm, Gazipur. The overall insect pest incidence was low in all the habitats and season except grasshopper (GH). Grasshoppers, green leafhopper (GLH) and white leafhopper (WLH) were the most abundant pests in all habitat and seasons. Grasshopper was found highest in rice bund (20.98/20 sweep) during Aus season followed by grass fallow (9.17) and seedbed (6.25). But the trend was change in T. T. Aman and Boro season and found highest in seedbed and irrigated rice (29.37 and 4.29/20 sweep respectively). No definite trend was observed in case of incidences of different insects in various seasons. Total insect incidence was highest in grass fallow habitat followed by seedbed and rice ratoon during Aus season the trend was changed in T. Aman and Boro season. Seedbed and irrigated rice were more harbored of insect pests in these two seasons respectively. Again, considering season, higher incidences of insect pests were found in Aus and T. Aman seasons followed by than the Boro season. Spider (SPD), damsel fly (Dam. fly), ladybird beetle (LBB) and carabid beetle (CDB) were the dominant predators in all the seasons and habitats. Spider found highest in irrigated rice of T. Aman and Boro season followed by rice bund of Aus season. LBB found highest in grass fallow habitat in Boro season whereas damsel fly on rice bunds in the same season. Irrespective of different natural enemies more incidences were observed in rice bunds, seedbed, grass fallow during Aus, T. Aman and Boro season respectively. Visual counting of randomly selected 20 hills showed that the population and the damage caused by insect pests were below the ETL in all the three rice seasons.	Insect pests and natural enemies will be monitored from different rice habitats and will be developed some models or forecast method in a long term.
2	**Expt. 2. Incidence of insect pest and natural enemies in light trap** **Duration:** Long term **Progress:** Rice insect pests and their natural enemies were monitored throughout the year by Pennsylvanian light trap from dusk to dawn throughout the year at BRRI headquarter, Gazipur and six BRRI regional stations. The highest number of insect pests were found at BRRI R/S Rajshahi followed by Barishal, Habiganj and BRRI H/Q, Gazipur but natural enemies was found highest in BRRI R/S Habiganj followed by BRRI RS Barishal, Rajshahi and BRRI Gazipur (Fig. 1). In contrast,	Number of insect pests and natural enemies will be monitored throughout the year and update

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	incidence of both insect pests and natural enemies was comparatively lower in RS Rangpur, Cumilla and Sonagazi. The abundance of BPH, WBPH, YSB and GLH was observed almost in all the locations. The highest number of BPH was observed during the month of November at Gazipur and Rangpur. But that was highest in December at Rajshahi. The highest peak of WBPH was observed in October at Gazipur but the peak was observed in November at Barishal and Rajshahi. Another small peak was found in May at Gazipur. The highest peak of YSB was observed at Rajshahi in the month of May, followed by Barishal and Sonagazi in the month of November.  **Fig. 1**.Total population of insect pests and natural enemies at BRRI HQ, Gazipur and six Regional Stations (RS). Another small peak observed in the month of August at Sonagazi. Highest peak of GLH was found in November at Sonagazi followed by Barishal, Gazipur, Rangpur and Rajshahi.Among the natural enemy's major peak of carabid beetle (CDB) was found in the months of December at Habiganj followed by Barishal. Peak of CDB also observed in November at Gazipur and Barishal. Several peaks of staphylinid beetle (STPD) were observed in the same locations of Barishal. Highest peaks were found in March and October in Barishal. Major peak of green mirid bug (GMB) was observed in November at Habiganj followed by Rajshahi and Gazipur.	the existent databank. Also, incidence and peak abundance will be estimated.
3	**Expt. 3. Survey of rice insect pests in selected Agro-ecological zones (AEZ's) of Bangladesh** **Duration:** Long term **Progress:** The insect pest population, their damage intensities and abundance of the natural enemies were surveyed during Aus and T. Aman 2019 in transplanted rice field of Barishal, Rajshahi, Sirajganj, Cumilla, Habiganj and Rangpur region to find out the incidence patterns of major insect pests and their natural enemies in different AEZ´s of Bangladesh and to create a data base of insect pests and natural enemies. Unfortunately, data were not collected during Boro season due to Lock down situation all over Bangladesh for COVID 19. Insect pests were below the economic threshold level (ETL) during Aus 2019 except YSB and LR in some areas of Rangpur region. Highest yellow stem borer (YSB)	Arthropods (pests and natural enemy) distribution pattern and incidence in different AEZ will be monitored. New insect pest species will be

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	found in Rangpur (7.30/20 sweep) followed by Barishal (3.42) and Cumilla (1.63/20 sweep). Leafroller (LR) population was found highest at Rangpur (3.86/20sweep) followed by Barishal (3.42/20 sweep) and Cumilla (1.28/20 sweep). Abundance of GLH was found highest in Cumilla (4.97/20 sweep) followed by Barishal (2.31/20 sweep) and Rajshahi (1.60/20 sweep). Irrespective of seasons and locations spider populations was found highest than other natural enemies. Highest spider (7.62/20 sweep) was found in Rangpur followed by Cumilla (6.09/20 sweep), Rajshahi (5.92/20 sweep) and Sirajganj (5.21/20 sweep). During T. Aman season, YSB population was found highest in Barishal (4.19/20 sweep) followed by Rajshahi (2.84/20sweep) and Cumilla (2.70/20 sweep). But LR population was found highest in Cumilla (3.13/20 sweep) followed by Rangpur (2.80/20 sweep) and Barishal (2.64/20 sweep).	identified.
4	**Expt. 4. Impact of lighting period on the catches of insects in light trap** **Duration:** Short term **Progress:** To identify the impact of lighting period on the incidence of insects in light trap, an experiment was conducted in Gazipur and Barishal. The insects, which were caught in light trap, were collected every hour after sunset and continued to monitor at 11:00 PM. From immediate sunset to fist three showed the highest number of insects trapped in light and thereafter declined (Fig. 2). Both insect pest and natural enemies showed the similar trends during the tested hours. However, the catches of hoppers and moths showed different trends at different time intervals after sun set. Hoppers show the decline trend with increasing the nighttime, but moth shows opposite direction to hoppers (Fig. 2). It indicates that moths attract light at late night. More studies are required to identify the best time to capture highest number insect using light trap. 	Impact of lighting period will be known. Specific lighting hour to capture maximum insect will be known.

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	Fig. 2. Catches of pests and natural enemies in light trap at different time intervals at BRRI Research farm. Bar represents the mean value of one-week catches. Error bar indicates the standard error.	
5	**Project II: BIO-ECOLOGY OF RICE INSECT PEST AND NATURAL ENEMY** **Expt. 1. Collection and identification of outbreak of grasshopper from Teknaf, Cox's Bazar** **Duration:** Short term **Progress:** A grasshopper like insect was first seen on April 18, 2020 in about 15 decimal of homestead forest of Uttar Lambari village Teknaf upazila, Cox's Bazar (Fig. 3). This outbreak created a panic among the local people since the insect was confused with concurrent outbreak of invasive desert locust in two neighboring countries like India and Pakistan. We collected samples from Uttar Lambari village (20.874692ºE, 92.265ºN) on 02 May 2020 and reared in laboratory upto adulthoods. Cytochrome c oxidase subunit I (COI) gene has been widely utilized to identify unknown species. We sequenced the COI gene of the collected samples and constructed phylogenetic tree. The sample sequence showed 87.58% similarity with known species of spotted coffee grasshopper, *Aularches miliaris* reported in India. Based on morphology and current sequence data of COI gene it can said that recent outbreak grasshopper like insect is *A. miliaris* (Linn.). The outbreak insect was not new in Bangladesh. Similar species, *A. miliaris* was previously recorded by Alam (1967) in the then East Pakistan. In addition, a similar species was also observed in Bogura. But later it was identified as *A. punctatus* Drury (Khan and Mannan 1990). However, the insect infestation of that area (Uttar Lambari) was successfully controlled by spraying insecticides through local DAE initiatives. So, this local problem was not related to the recent outbreak of destructive desert locust in some parts of India and Pakistan. We also tested the consumption rate of collected insects. Each insect (nymph) can consume 1.12 cm^2 area of mango leaf/day.  **Fig. 3. (a)** Photo of outbreak insects on plants observed in Uttar Lambari (20.874692ºE, 92.265ºN) village of Teknaf upazila, Cox's Bazar. **(b)** Neighbor joining phylogenetic tree and the position of collected sample (yellow shaded, unknown) among other reported species based on COI	The biology and feeding pattern of insect pest will be determined. Status of any pest and their risk in Bangladesh will be known.

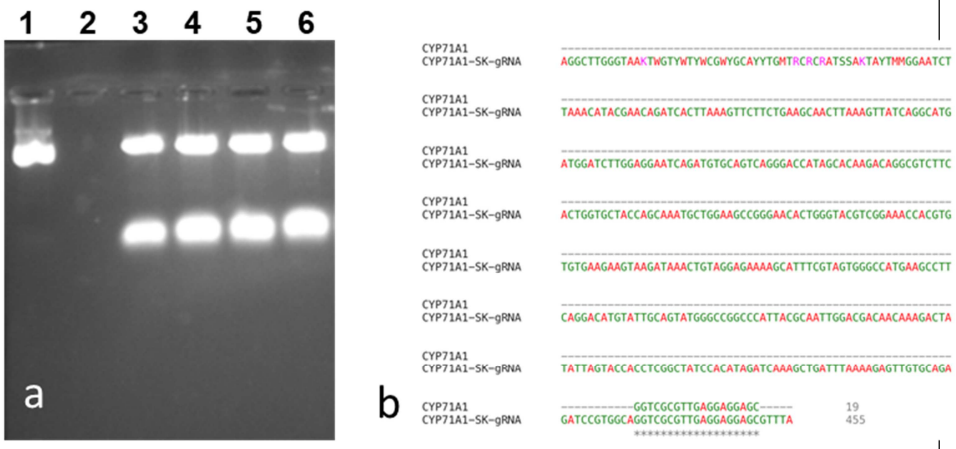
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	gene sequence.	
6	**Expt. 2. Bio-ecology of an invasive insect pest, fall armyworm** **Duration:** Short term **Progress:** Biology of fall armyworm (FAW) was studied at 28^{o}C in greenhouse. It has four distinct life stages including egg, larva, pupa and adult. They require approximate 30 days to complete their life cycle at summer season, but it varies highly in seasons. **Egg:** Gravid female laid eggs in clusters ranged from 30 to 170. The eggs were dorso-ventrally flattened, initially these were pale green for one day turned to golden yellowish and ultimately turned to black before hatching. The female covered a layer of scales on the egg mass and this gave moldy appearance. Incubation period ranged 3 - 5 days. **Larva:** First instar larvae were whitish with a black head, and turned greenish brown in the second instar. The third instar was brownish with three dorsal and lateral white lines. Fourth to the sixth instars were brownish black and had three white dorsal lines and alight lateral line. Black tubercles were found dorsally on the body, which bears spines. Most distinguishing characteristic of FAW was white inverted "Y" shape line observed on head. Each larva passed through six distinct instars over a period of 21 - 30 days at 28^{o}C in greenhouse. **Pupa:** We reared in petridish and 6 wells cell culture plate with artificial diets. So, pupation took place under food pile or on petridish. Pupa looks redish brown in color. Male and female can be distinguished during pupal stage by looking the distance between genitalia and anal slot. Female shows longer distance between genitalia and anal slot than that of male. **Adult:** Adult is brown and shaded gray. The forewings of male have triangular white spots at the tip and close to the centre of the wing. But there are no distinct marks of white spots observed on the forewings of female. At adulthood, we can identify male and female adult using this distinguish characteristics found on forewings. However, the hind wings of both male and female are iridescent silver-white with a narrow dark border. Adults lived 8 – 12 days.	Details biology and feeding pattern of fall armywormin Bangladesh will be determined.
7	**Expt. 3. Impact of salinity on rice insect BPH and rice growth** **Duration:** Mid term **Progress:** The experiment was established in greenhouse of Entomology Division, BRRI, Gazipur. Five levels of salinity (2.0, 4.0, 6.0 and 8.0 dS/m) including control (0.0 dS/m) were used as treatment. Plants of BRRI dhan47 in earthen pots were used in this experiment. After hatching, total numbers of BPH were highest in control followed by 4 and 2dS/m. There after declined with increasing salinity level. After 45 days, highest population of BPH developed at 0dS/m and 2dS/m and the lowest was at 8dS/m salinity (Fig. 4). The reason behind the highest population of BPH was found at 0dS/m might be due to growth and development of plants was better in control than the saline treated plants. Nymphal survival rate was also highest in 0dS/m and lowest in 4dS/m. In higher salinity level, plant growth hampered therefore BPH could not get sufficient food from the plant. This	Biological parameters of BPH at elevated salinity level will be generated. How salinity influence the BPH in rice field will be determined.

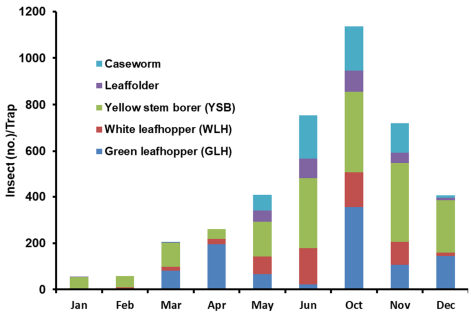
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	might be a cause for low survival rate in high salinity level (Fig. 4).  **Fig. 4.** Effect of salinity on population development of brown planthopper during July19-June 20.	
8	**Project III: BIOLOGICAL CONTROL OF RICE INSECT PESTS** **Expt. 1. Leveraging Diversity for Ecologically Based Pest Management** **Duration:** Mid term **Progress:** Three experiments on Leveraging diversity for ecologically based pest management were conducted in BRRI farm Gazipur, BRRI RS, Rajshahi and farmers field in Alimganj, Paba, Rajshahi during T. Aman season and 5 experiments in Boro season to conserve natural enemies in rice field and to validate eco-friendly insect pest management technology in farmer's field. Two treatments were used in all locations i.e., T_1=Sesame and cosmos flower were grown on rice bunds, T_2=Farmers practice i.e. prophylactic use of insecticide. Insect pest infestation both in T. Aman and Boro seasons in all locations remains below the ETL in both the treatments T_1 and T_2. In T_2 insecticide were used 3 times. Irrespective of seasons and locations more natural enemies were observed in T_1 where flowering plants/sesame grown on rice bunds. Brown plant hopper and YSB egg parasitisim and RLF larval parasitism observed highest in T_1 (23.67, 34.25 and 29.23% respectively) compared to T_2 (3.60, 0 and 4.4 respectivley) at BRRI, Gazipur. Though grain yield obseved simillar both in T_1& T_2 (5.60 and 5.65 t/ha respectivley). But additional sesame produced in T_1 which increase the rice equivalent yield (REY) in T. Aman season. In T_2 insecticide used 3 times during T. Aman season but yeild was simillar to that of T_1. But extra profit comes from T_1 with additional sesame production and no use of insecticide. More or less simillar results were also observed from five experiments of Boro season. Highest natural enemies, percent RH egg parasitism by *Trichogramma zahiri*, YSB egg parasitism by *T. chilonis* & *Telenomous rowani* and BPH egg parasitism by *Anagrass* sp. were observed in rice field with nectar-rich flowering plants on bunds. However, least natural enemies and parasitism were found in rice field where three times insecticides were applied. Moreover, there was no yield reduction observed in rice field surrounding by flowering plants on bunds compared with insecticide application. So, farmers should avoid the toxic and hazardous insecticides to control the insect pests by growing nectar-rich flowering plants on the bunds of rice crop.	The use of insecticide will be reduced at the early crop stages by enhancing the buildup of different natural enemies in rice agro-ecosystem.
9	**Expt. 2. Study on entomopathogenic fungi to control BPH** **Duration:** Mid term	Efficacy of

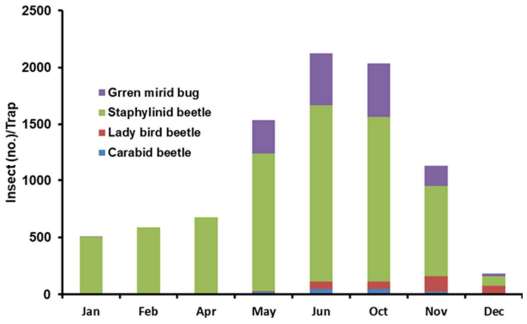
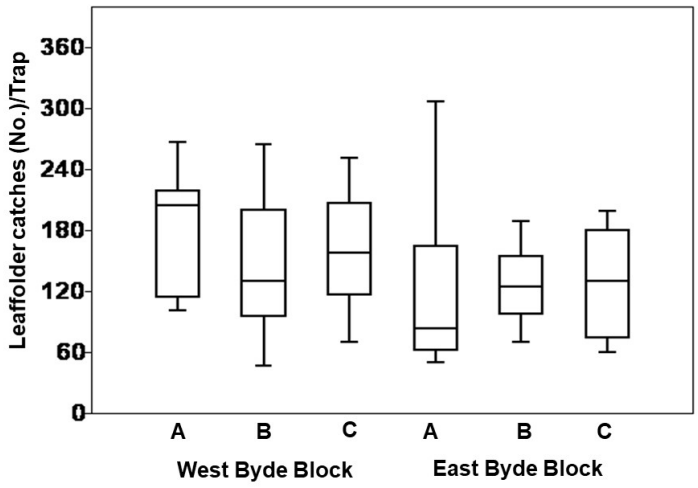
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	Progress: The study was conducted at Entomology greenhouse, BRRI to isolate the fungi from naturally infected BPH and to know the pathogenicity of entomogenous fungi against BPH. Potted BR3 plants were infested by 10 3rd-4th instar BPH nymphs of greenhouse populations and confined by mylar film cages. Two different doses of entomopathogenic fungi were sprayed to the plants. There were control plants with BPH without any spraying of fungi. Number of alive BPH was collected after 1, 3 and 7 days of spraying. No significant difference was found on mortality of BPH after 1 and 3 days of inoculation of fungi compared to control. However, fungi showed 33.0 to 41.7% efficacy to control BPH after 7 days of inoculation, which was significantly different from control.	entomopathogenic fungus against BPH will be determined.
10	**Project IV: CROP LOSS ASSESMENT** **Expt. 1. Effect of dead heart and white head on grain yield of BRRI rice varieties** **Duration:** Mid term **Progress:** The experiment was conducted at BRRI research farm, Gazipur to determine the yield loss and recovery abilities of BRRI dhan87 against stem borer damage. Four hills were randomly selected diagonally from each plot and infested with the 1st instar larvae of one egg mass after 35 days after transplanting (DAT). Another four hills from the same plots were also selected as control. On an average 0.94% dead heart and 2.81% white head observed when rice plant was infested at 35 DAT. There was no significant difference was found in tiller and panicle per hill between infested and un-infested hill. But significantly higher filled grain number (929.31/hill) was found in infested hill compared to un-infested hill (736.63/hill). As a result, grain weight was found highest (22.22 g/hill) in infested hill compared to un-infested hill (16.66 g/hill). This indicated that when YSB larvae damaged any tiller of a particular hill the plant produces additional tiller of the same hill, which compensate the loss of damaged tiller. If YSB damages panicle of a hill plant supply more nutrient to another panicle. As a result, more filled grain number was found in other panicle of infested hills. So, no yield loss was found by the damage of YSB at early crop stage when dead heart and white head remain below 1 and 3% respectively. BRRI dhan87 compensate the dead heart tiller by producing additional tiller and white head damage compensate by producing more filled grain in other panicles of the same hill. It is one-season results so need further study to confirm it.	Damage, yield loss and its relation to infestation severity in YSB prone areas will be assessed. Compensation abilities and yield losses of different rice varieties due to stemborer infestation will be known.
11	**Project V: EVALUATION OF CHEMICALS AND BOTANICALS AGAINST RICE INSECT PESTS** **Expt. 1. Test of different insecticides against major insect pests of rice** **Duration:** Long term **Progress:** A total of 132, 09, 10 and 4 commercial formulations of insecticides were evaluated against BPH, YSB, RLF and rice weevil respectively. Among them 124, 03, 03 and 04 were found effective against BPH, YSB, RLF and rice weevil respectively. Among all the tested insecticides 36 bio-pesticides were found effective against different insects.	Effective insecticide will be identified and recommended for registration in Bangladesh.
12	**Expt. 2. Fumigation action of botanical oils against stored grain insect**	Non-chemical

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	pests **Duration:** Mid term **Progress:** The experiment was conducted in the field lab of Entomology Division. Airtight glass fumigation chambers (12x12x12 inch3) with sliding doors were used for this study. Both neem and mahogany oil mixed with 70% ethanol. Five (5) ml from mixture were placed in mosquito liquid vaporizer machine (Good knight), each good knight was placed into the respective glass fumigation box, and the boxes were tightly closed. Ten insects, rice weevils (adult) and angoumois grain moth (adult) collected and kept them in fine mesh cloth covered plastic jar (capacity 500 ml). The plastic jars were carefully placed in the fumigation chambers and the chambers were closed quickly. Fumigation procedure continued for 48 hours. Experimental units were arranged in completely randomized design (CRD) with 8-12 replications. At the end of the fumigation period, insects were transferred to plastic jars containing natural diet (rice grain). Final mortality, deformation was watched for seven days. The results indicated that mahogany oil fume caused significant mortality to both rice weevil and angoumois grain moth compared to the control. However, the neem oil did not cause significant death the tested insects compared to the control. Mahogany oil caused 90.0 to 98.41% death whereas neem oil caused 12.2 to 22.7% in the rice weevil and angoumois grain moth respectively. This study indicates that mahogany oil would be an effective product for controlling stored grain insect pests through fumigation process. However, more research is required for mechanism of this mortality by mahogany oil.	biopesticide will be identified for stored grain insect pest control.
13	**Expt. 3. Analysis of insecticide residues in rice** **Duration:** Long term **Progress:** In this study we detected pesticide residues from rice sample using LC-MS. Four ml (4 ml) of water was added to 2 g of rice powder in 50 ml falcon tube. Extraction was conducted acetonitrile (ACN) and AOAC with primary secondary amine (PSA). Detection was carried out by an LCMS-2020 fitted with electrospray ionization (ESI) probe operated in the positive ion mode. The concentrations of chlorantraniliprole were 0.028 and 0.055 mg/kg in Chinigura and Jasmin rice respectively. The 0.28 mg/kg thiamethaoxam was also found in Indian rice. However, the detected amount of both chlorantraniliprole (MRL: 0.4 mg/kg EU) and thiamethoxam (0.6 mg/kg) in the samples were below the Maximum Limit of Residues (MRL).	Pesticide residue remained in rice would be known. Human health risk due to rice consumption would be identified.
14	**Expt. 4. Use of nanoparticle for controlling rice insect pests** **Duration:** Long term **Progress:** Despite the fact that there are several available alternative methods, pest control is still largely based on the use of pesticides, in the sense of organic chemical-based ingredients that are applied on the crops, the commodity, or the urban environment. Recently, nanoparticle shows a promising environmentally safe technology to control insect pests. In this study, we tested two nanoparticles including Ag and Cu against brown	Effective nano-particle against rice insect pest will be identified.

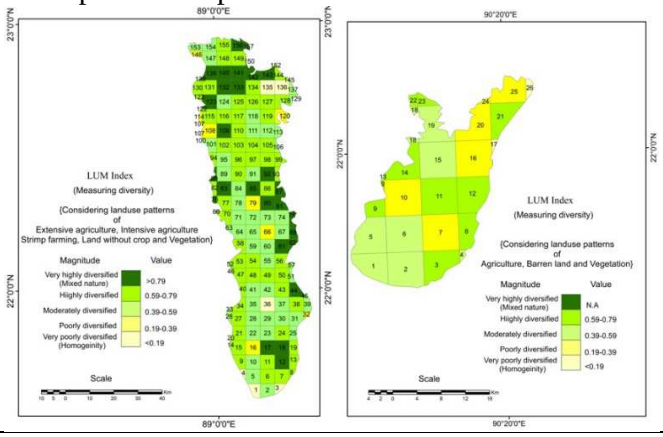
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	planthopper (BPH). These two nanoparticles were gifted from a Japanese Professor Dr Enoch Y. Park. The efficacy of Ag and Cu nanoparticles against BPH was tested at three different concentrations (500, 250, and 125 μg mL−1), which were prepared by dilutions with distilled water. Distilled water was used as a negative control treatment. Ten 15-days-old rice seedlings were dipped into each nanoparticle solution at three concentrations. After 60s seedlings were removed from the solution and allowed to air dry. The rice roots were wrapped in moistened cotton. The treated seedlings were then placed into a 25 mm test tube. The 3^{rd} -4^{th} instar nymphs of BPH (10) were released into each test tube. The test was conducted at 27 ± 1°C and 16:8 h L:D. Mortality was recorded after 48 and 120 h. The nymphs were considered dead if they failed to move when gently prodded with a fine bristle. Both Ag and Cu nano-particles showed below 20% mortality of BPH nymph. This result indicates that tested nanoparticles are not effective against BPH. However, Ag nanoparticle showed comparatively higher mortality than Cu against BPH. More experiments with new synthesis nanoparticles are planned to test again.	
15	**Project VI: HOST PLANT RESISTANCE** **Expt. 1. Screening of advanced breeding lines against major insect pests of rice** **Duration:** Long term **Progress:** A total of 290 advanced breeding lines and INGER IRBPHN materials were evaluated at green house of Entomology division to identify resistance sources against major insect pests of rice. Among them 7 breeding lines (Path 2441, IR98849-GAZ-2-2-4-1, BR9880-27-4-1-18, BR9880-2-2-2-1, BR9880-40-1-3-34, BR9880-45-2-2-38 and BR(Bio)10376-AC11-3-1) and two IRBPHN lines (SVIN350, SVIN351 and SVIN357, SVIN266) showed moderately susceptible (score 5) reaction to BPH, 6 breeding lines {BR (Bio) 11447-1-28-14-3, BR 9669-21-2-1-19, IR 98841-GAZ-4-2-1-2, IR98841-GAZ-8-1-3-1, BR(Bio)10376-AC9-1-3 and BR(Bio)10376-AC11-3-1)} were found moderately susceptible to WBPH and 4 breeding lines BR(Path)12452-BC3-16-19, BR (Bio) 11447-3-10-7-1,IR 105837-8-45-1-1and BR 9891-19-2-2-8) to GLH (Score 5). Susceptible Check: BR 3 (for all), Resistant ck: T27A, IR64 Scores were made according to SES. BPH= brown planthopper, WBPH= white-backed planthopper, GLH= green leafhopper, R= resistant (score 0-1), MR= moderately resistant (3), MS= moderately susceptible (5), S=susceptible (>7).	BPH resistant rice breeding will be identified and used for further resistance breeding program.
16	**Expt. 2. Identification of BPH resistant sources from local germplasm** **Duration:** Long term **Progress:** A total of 500 rice germplasm were evaluated against BPH in the net house of Entomology Division to identify BPH resistant rice accession. Among them 31 rice accessions namely Acc480, Acc481.Acc482, Acc485, Acc486, Acc487, Acc490, Acc559, Acc572, Acc577, Acc578, Acc579, Acc589, Acc591, Acc601, Acc602, Acc614, Acc694, Acc719, Acc811, Acc812, Acc834, Acc860, Acc874, Acc875,	BPH resistant rice germplasm will be identified and used for further

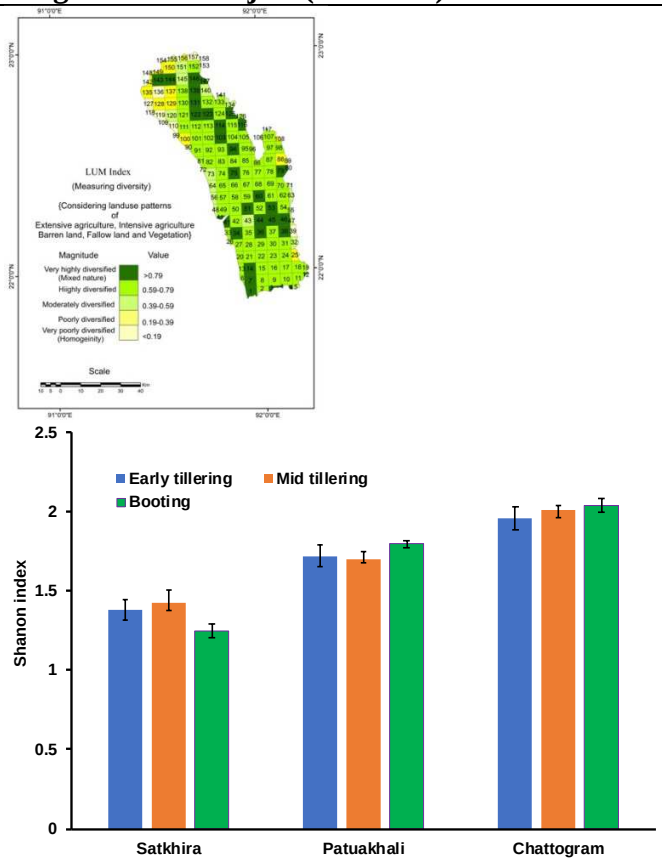
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	Acc883, Acc884, Acc885, Acc994, Acc995, and Acc996 showed moderately susceptible reaction (score 5) to BPH.	resistance breeding program.
17	**Expt. 3. Suppression of serotonin synthesis in rice using CRISPR Cas9 genome editing tool for insect control** **Duration:** Long term **Progress:** The oligonucleotide sequence of target insertion part of CYP71A1 gene was purchased from Macrogen company (Humanizing Genomics, Seoul, Korea) via Biotech Concern (Dhaka, Bangladesh). The SK - gRNA vector was cultured overnight in 25ml LB (Luria-Bertani) liquid medium added with ampicillin antibiotic and DNA was extracted from cultured cells using the FavorPrep Plasmid DNA Extraction Mini Kit (Cat No. FAPDE050, FAVORGEN, Biotech CORP, Taiwan). Purified SK - gRNA was quantified using NanoPhotometer® (Implen GmbH, München, Germany) and 1 µg DNA was used for each digestion reaction. The DNA of SK-gRNA was digested with AarI restriction enzyme for ligation with target gene. Respective amount of each component in a restriction reaction was taken in a 1.5 ml microtube and incubated at 37°C for 60 min. After 60 min, the digested product was checked using agarose gel electrophoresis and digested SK-gRNA DNA was again purified from agarose gel using FavorPrep Gel/PCR purification Mini Kit (Cat No. FAGCK001, FAVORGEN, Biotech CORP, Taiwan).  **Fig. 5.** (a) Electrophoresis of digested SK-gRNA for ligation with target site of CYP71A1. Lane 1: SK-gRNA; lane 2: Blank; lanes 3 – 6: SK-gRNA digested with AarI. (b) Alignment of the original target site of CYP71A1 and the sequence of recombinant CYP71A1-SK-gRNA. * indicates the similarity between original target site and recombinant CYP71A1-SK-gRNA. In the production of CYP71A1 knockout (CYP71A1-KO) rice plant, a 19 bp fragment (5'- GGTCGCGTTGAGGAGGAGC -3') of CYP71A1 gene was designed as the target and inserted into the vector pC1300-cas9 for CRISPR/Cas9 knockout. The purified SK-gRNA DNA digested with AarI restriction enzyme was used for ligation with target part of CYP71A1. The	BPH and YSB resistant rice variety will be developed. Advanced genome editing tools will be adopted in rice insect pest management in Bangladesh.

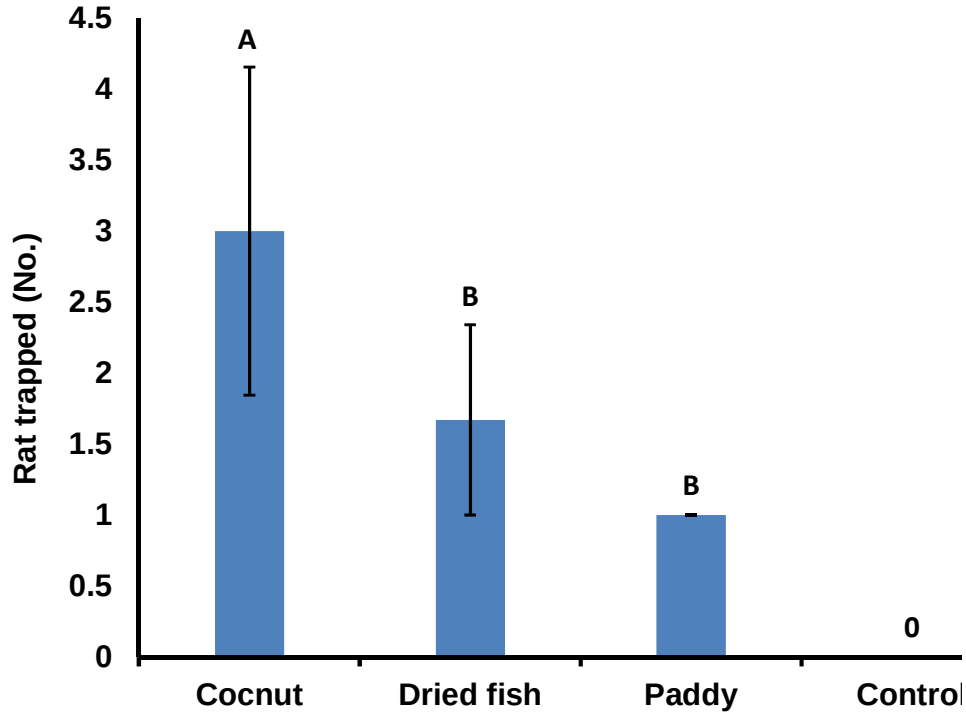
Sl. No	Research Progress Program area/Project (Duration)	Expected output
	target part of CYP71A1 gene was inserted at the AarI - site in SK-gRNA following the ligation protocol. The target fragment of CYP71A1 gene and SK-gRNA vector were ligated in a reaction mixture containing 3 µl target fragment (primer F+R), 20 – 50 ng of SK-gRNA fragment, 0.5 µl of 10X buffer (T4 ligation buffer) and 0.5 µl of T4 DNA ligase, followed by incubation at 16°C for 8 h (overnight). After 8 h, 5 µl of ligation reaction product was transformed into chemically DH5α cells following the standard transformation protocol. The transformation product was kept for culture in LB plate at 37°C for overnight. Recombinant SK-gRNA was checked by PCR, electrophoresis, and sequencing. The purified recombinant SK-gRNA vector DNA was sent to National Institute of Biotechnology (NIB), Savar, Dhaka for sequencing. Sequencing result shows 100% similarity with original target sequence and recombinant SK-gRNA – CYP71A1 (indicated by *) (Fig. 5). The recombinant SK-gRNA – CYP71A1 will be cloned again into pC1300-Cas9 vector for next step.	
18	**Project VII: INTEGRATED PEST MANAGEMENT** **Expt. 1. Use of solar light trap for insect pest management in crop field** **Duration:** Mid term **Progress:** Pilot scale research and field trials were conducted in rice field in BRRI research field, Gazipur. Twelve solar light traps were installed at West byed research field and insect pest catches from each light trap were recorded every day. Significant number of insect pests that can cause damage to rice were caught in each month (Fig. 6). Highest numbers of insect pests were trapped in October followed by June and November and lowest number of insect pest were caught in January. Highest number of GLH and YSB were recorded in October 2019 (Fig. 6). Among the natural enemies, staphylinid beetle commonly trapped in all months and highest abundance was observed in June followed by October (Fig. 6). The predator green mirid bug was found in May, June, October and November. This result indicated that solar light trap would be a promising tool for monitoring and integrated pest management (IPM) in rice field.  	Environment friendly insect pest management technology will be developed.

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	 **Fig. 6.** Monthly catches of insect pests and natural enemies in solar light trap at BRRI, Gazipur. Each bar segment represents the mean value of three trap catches.	
19	**Expt. 2. Use of sex pheromone to control rice leafroller, *Cnaphalocrosis medinalis*** **Duration:** Mid term **Progress:** Pheromone lures were collected from China and used for field evaluation in Gazipur at T. Aman 2019. The optimal blend of used pheromone was Z11-18:Ald, Z13-18:Ald, Z11-18:OH and Z13-18:OH at a ratio of 3 : 25 : 3 : 3. The optimal dosage is 500 µg Z13-18:Ald per poly-vinyl chloride (PVC) tubing lure. Traps were installed in three blocks of West and East byed of BRRI research field. The trap was placed in rice field @ of 15-20 traps/ha. Significant number of leaffolders that could cause damage to rice were caught in each pheromone trap at each block. Catches of leaffolder in trap varied in different block of BRRI research field (Fig.7). Highest number of leaffolder was caught in A block of West byed. This result indicates that pheromone trap is very effective to monitor as well control leaffolder in rice field.  **Fig. 7.** Catches of leaffolder in pheromone trap at BRRI, Gazipur during T. Aman 2019.	Alternate insect pest management option could be explored. Use of chemical insecticide will be reduced.
20	**Expt. 3. Strengthening environment friendly research on insect pests for rice yield maximization** **Duration:** Mid term **Progress:** The experiment strengthening environment friendly research on	Farmers will be benefited for

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	insect pests for rice yield maximization was conducted in farmer's fields to demonstrate sustainable insect pest management practices in farmer's field and to reduce insecticide use in rice production. A total of 100 demonstrations were established during the reporting period, which covered 93.57 acres of land in 24 districts. One portion of each farmer's field was remained under the respective farmers' supervision without any intervention treated as T_2 (Farmers practice). The other portion was managed with BRRI recommended practices treated as T_1 (Researchers practice). BRRI released popular varieties including new varieties were used in different locations of Bangladesh. Same varieties were used both in T_1 and T_2. In T_1, rice field was refrained from insecticide use up to 30 days after transplanting (DAT) to increase natural enemies in rice field. Insect pest in the rice field was monitored fortnightly by sweeping and visual counting of randomly selected 20 hills. Perching @100/ha was also used in T_1 and insecticide used ETL based or not. In T_2 treated plot the farmers were used 3 times insecticide to control the insect pests. On an average 0.48 t/ha yield increase in researchers practice plot compared to farmers practice plot. The national average yield gap is 20-25% but in the demonstrations irrespective of seasons and varieties the yield gap was observed 9.27%, which indicated yield gap also reduced. The demo farmers sometimes tried to follow the researchers practice also. So yield gap reduced to some extent. As a result, 18.24 tons additional rice produced in researchers practice plot compared to farmers practice plot during the reporting year. Not only that insecticide application reduced 2 times in researchers practice which save insecticide 760 kg (granular). The market value of this insecticide is 91,200 /- (ninety-one thousand two hundred) only. Moreover, it saves environment from insecticidal pollution. Most of the farmers in Bangladesh habituated to use granular insecticide during 1st urea top dressing without thinking its need. The demo farmers of these programs are motivated that no need to use insecticide application at early crop stage (30-40 DAT). So, it needs such type of more demonstration in farmers field all over the Bangladesh.	controlling major insect pests of rice by using BRRI recommended practices.
21	**Expt. 4. Landscape structure influences the natural pest control services in rice field** **Duration:** Short term **Progress:** We conducted 10 field experiments at Patuakhali and Satkhira during Boro 2019-20 seasons in Bangladesh. To quantify the pest control services in rice field, we released 10 gravid brown planthoppers (BPH) in a cage confining 9 hills. We also released 10 BPH in other four open places in the same field, which were exposed to natural enemies. Natural pest control agents get chance to destroy planthoppers and its eggs within exposed area. Fields were monitored every alternative day to check either any natural enemies enter into cage and to be continued up to crop harvest. Results showed that significant number of BPH developed in cage, which can cause damaged to grain yield. Natural enemies destroyed almost all BPH released in field and reduced 95% and 80% pest population in Satkhira and Patuakhali respectively. Population development in cage significantly higher than in open field because natural pest control agents	How landscape structures insects' abundances in agro-ecosystem will be known**.**

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	including LBB, spiders, staphylinid beetle, and green mirid bug were active in the field. This result indicates that significant amount of natural pest control services occurs in crop field. Moreover, we recorded the number of two predators, ladybird beetle and spiders from studied fields. Significant higher number of LBB and spiders was observed in Patuakhali than that in Satkhira. To identify the mechanism of the higher abundance LBB in Patuakhali we analyzed the landscape structure at 1000m radius of each experimental site.	
22	**Expt. 5. Geographic heterogeneity influences the species diversity of rice arthropods** **Duration:** Short term **Progress:** The habitat heterogeneity hypothesis proposes that regions with higher habitat heterogeneity can provide more niches for coexisting of more species. In addition, human disturbance has strongly altered global ecosystems especially in the past century and thus may be an important factor modifying geographic diversity patterns. Here, we evaluated these explanations with geographic diversity data of insects. First, we measured the LUM index diversity of Satkhira, Patuakhali and Chattogram districts considering land use patterns of extensive agriculture, intensive agriculture, land without crop and vegetation. Data were collected from 30 locations of each geographic area for species diversity analysis. Sampling was conducted at three stages of rice growth in each field. Results showed that Chattogram has abundant very highly diversified area (mixed nature) followed by Satkhira. However, Patuakhali has no very highly diversified areas (Fig. 8). Higher arthropod species diversity was found in Chattogram than Satkhira and Patuakhali irrespective crop growth stages (Fig. 8). This can be explained that higher arthropod diversity was observed in Chattogram due to its very high diversity index (Fig. 8). Thus, higher habitat heterogeneity of Chattogram induces the higher number of arthropods in crop field.  	How geographic diversity influences the arthropod diversity in rice field will be determined.

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	 **Fig. 8.** LUM index of three geographic studied areas in Bangladesh (upper panels). Species diversity (Shanon index) at three geographic areas in Bangladesh (lower panel). Error bar indicates the standard error.	
23	**Project VIII: VERTEBRATE PEST MANAGEMENT** **Expt. 1. Ecologically based management of rats in rice field** **Duration:** Mid term **Progress:** The use of bamboo trap is becoming a popular among the farmers since it can be easily made by local people using available indigenous raw materials. The trap can also be placed in crop field easily for trapping rats. Therefore, a trial was designed to identify the best food to attractiveness of rats in bamboo trap. The attractiveness of each food was calculated as the number of rats trapped. Different foods including coconut, dried fish and paddy were used in this study and compared their attractiveness in rice field. Field trials were conducted at BRRI Charbadna research farm in Barishal. Results indicated that coconut has the highest power to attract rats in bamboo trap overnight in field condition (Fig. 9). Significant differences were found among the tested food in bamboo trap. Bamboo trap was also applied without any food, but no rat was trapped. This indicates that bamboo trap can't be used without any food for rat management. However, more trials with diverse food sources are recommended to identify best food for higher attractiveness of rats.	Environmentally safe rat management approach will be developed. Farmers will be benefited for controlling rat management in rice field.

Sl. No	Research Progress Program area/Project (Duration)	Expected output
	 **Fig. 9.** Effect of different foods used in bamboo trap for rat attraction. Trap with different foods were placed in rice field at Charbadna farm, Barishal. Bar bearing the same letter did not differ significantly at 5% level of significance. Error bar indicates the standard error.	

Rice Farming System Division

Table-2

Research Progress 2019-2020

Sl. No.	Research Activities	Progress
1.	Development of four-crop cropping patterns for favorable irrigated ecosystem in medium highland	Among the six tested cropping patterns the highest rice equivalent yield (26.40 t ha^{-1}) was obtained from Field pea-Mungbean-T. Aus-T. Aman cropping pattern followed by Potato-Sweet gourd-T. Aus-T. Aman cropping pattern (24.47 t ha^{-1}).
2.	Identification of rice variety in Boro-Fallow-T. Aman cropping system in high to medium highlands for sustainable productivity	In T. Aman season, BRRI dhan87 and BRRI dhan71 yielded significantly higher than BRRI dhan57, whereas in the Boro season, BRRI dhan58 gave significantly higher yield than BRRI dhan63 under different varietal combination of T. Aman and Boro rice in Boro-Fallow- T. Aman cropping pattern. BRRI dhan87-BRRI dhan58 cropping pattern produced the highest total cropping pattern yield among the tested 10 cropping pattern.

Sl. No.	Research Activities	Progress
3.	Effect of flooding stress on emergence, growth and yield of rice under anaerobic condition in Boro-Fallow- T. Aman cropping pattern	Four anaerobic germination potential genotypes along with their donor, recipient and one drought tolerant genotype were tested in field flooded with 3-5 cm water in Boro-Fallow-T. Aman cropping pattern. Among the tested genotypes, Ciherang-Sub1-*AG1-AG2* and IR 15D 1055 yielded significantly higher than the check (Ciherang-Sub1) under flooding stress
4.	Improvement of Jhum cultivation through the replacement of local rice with the modern Aus rice in hilly areas	Four HYV Aus rice varieties were tested in different location in three districts of hilly region in jhum cultivation system. Highest average yield was found in BRRI dhan83 which was followed by BRRI dhan48.
5.	Fertilizer management in HYV Aus rice in Jhum cultivation	Fertilizer application around dibbling hole gave more than 1 t ha^{-1} yield advantages over farmers' practice in fertilizer management of Aus rice in jhum cultivation system in hilly area.
6.	Inclusion of Mustard in Boro-Fallow-T. Aman cropping pattern in the valley of hilly area	Mustard was incorporated in Boro-Fallow-T. Aman cropping pattern in the plain land of hilly area in six locations in Rangamathi districts. Mustard BARI Sorisha 14-BRRI dhan84-BRRI dhan70 gave 47% higher REY than the existing check cropping pattern of Jonokray-Fallow-BRRI dhan49.
7.	Intensification of Fallow-Fallow- T. Aman area through the inclusion of modern Aus rice in plain land in hilly areas	In Chattogram hill tract area T. Aus was introduced in Fallow-Fallow- T. Aman cropping pattern in 24 Upazilas. In T. Aus season, the grain yield of BRRI dhan48 ranged from 4.21 to 4.66 t ha^{-1} and BRRI dhan82 ranged from 4.41 to 4.61 t ha^{-1} in different upazilas. BRRI dhan70, BRRI dhan71 and BRRI Hybrid dhan6 gave the average grain yield of 4.49, 4.63 and 4.63 t ha^{-1} at different locations. Thus inclusion of Aus rice in existing Fallow-Fallow-T. Aman cropping pattern and using appropriate T. Aman varieties the productivity could be increased significantly.
8.	Piloting of cropping pattern technologies to increase the total productivity in Kishoreganj and Khulna	Under piloting of cropping pattern technologies program, among the evaluated cropping patterns BARI Alu 32-BJRI Tosha Pat 8-BRRI hybrid dhan6 cropping pattern had higher rice equivalent yield (27.39 t ha^{-1}), which was 171% more yield than the existing cropping pattern, Boro-Fallow-T. Aman followed by Mustard-Boro-T. Aman cropping pattern in Kishoreganj. In Khulna, incorporation of Mustard in existing cropping pattern, Boro-Fallow-T. Aman increased 28% REY.
9.	Improvement of Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed, pulses and Aus	Improved cropping pattern, Mustard-Boro-T. Aman and Mustard-Mung bean-T. Aus-T. Aman produced 13.76 and 16.23t/ha rice equivalent yield compared

Sl. No.	Research Activities	Progress
	rice	to the check cropping pattern of 8.38 t/ha in the farmers' fields of Shreepur, Gazipur.
10.	Productivity evaluation of different cropping patterns in saline ecosystem	The experiment was conducted at Dhigholia, Dacope and Daulotpur, Khulna with the four cropping patterns; CP_1: Mustard (BARI Sorisha-14)–Boro (BRRI dhan67)-T. Aman (BRRI dhan76), CP_2: Wheat (BARI Gom-25)-Sesame-T. Aman, CP_3: Watermelon–Fallow-T. Aman, CP_4: Boro-Fallow-T. Aman. Watermelon–Fallow-T. Aman yielded (23.90 t ha^{-1}) 121% higher rice equivalent yield than the existing Boro-Fallow-T. Aman cropping pattern.
11.	Screening of exotic date palm (*Phoenix dactylifera*) genotypes for agro-forestry in the drought-prone ecosystem	A research initiative has been under taken at Mujibnagar Complex for the development of elite date palm genotype suitable for Bangladesh. Ten varieties of *P. dactylifera* were planted in 2013 in BRRI Head Quarter with 500 saplings and another one in Mujibnagar Comolex, Mujibnagar, Meherpur with 1100 saplings. As the population was derived from sexual propagation all the plants are of segregated nature. Among the plant population 195 male and 30 female plants have been identified. Shape, size, colour and taste of fruits and other phenotypic characters were different from plant to plant.
12.	Performance of different cropping patterns for year-round vegetable production under agro-forestry system with exotic date palm (*P. dactylifera*)	Six cropping patterns, consisted of vegetables were tested as year-round vegetable production under agro-forestry system with exotic date palm. Among the six cropping patterns Pumkin-Mukhikachu gave the highest gross margin of 143.86 thousand Tk/ha. It was followed by Carrot-Mukhikachu (143.50 thousand Tk/ha).
13.	Evaluation of different rice-based cropping patterns under agro-forestry system with exotic date palm (*P. dactylifera*)	Six rice-based cropping patterns were tested under agro-forestry system with exotic date palm. All crops were grown in between the two rows of date palm established at 3 m distance. DS Aman (BRRI dhan71)-Pumpkin gave the highest gross margin of 67.75 thousand Tk/ha which was followed by DS Aman (BRRI dhan71)-Chilli (57.93 thousand Tk/ha). The lowest GM (29.42 thousand Tk/ha) was from DS Aman (BRRI dhan71)-Barley.
14.	Evaluation of different year-round fodder production under agro-forestry system with exotic date palm (*P. dactylifera*)	Six cropping sequences with the combinations of winter and summer season fodder crops were tested in agro-forestry system in date palm orchard. Crops were grown in between the two rows of date palm established at 3 m distance. Cowpea-Maize gave the highest gross margin of 58.92 thousand Tk/a. It was followed by Oat-Maize CP (47.67 thousand Tk/ha). The lowest GM (27.35 thousand Tk/ha) was from

Sl. No.	Research Activities	Progress
		Triticale–*Bhura*.
15.	Performance of different spices crops in various cropping patterns under agro-forestry system with exotic date palm (*P. dactylifera*)	Six cropping patterns composed of different spices crops were grown in between the two rows of date palm established at 3 m distance. Among the six cropping patterns Fallow-Turmeric gave the highest gross margin of 184.45 thousand Tk/ha. It was followed by Chilli-Turmeric (180.51 thousand Tk/ha) and Onion-Turmeric (171.25 thousand Tk/ha). The lowest GM (97.45 thousand Tk/a) was from Fallow-Ginger CP.
16.	Development of Vegetables, Fish and Fruit System for shallow Mini Pond.	The main components were growing aroid (Panikachu-3) and fish (Telapia) in the pond, winter vegetables, summer vegetables and Papaya on the bank of surrounding pond throughout the year. The gross margin of Aroid+Fish with stocking density: 02 piece/m^2 was 595%, 503% and 405% higher than the only fish - Stocking density: 01 piece/m^2, only aroid in the pond and Aroid+Fish (Stocking density: 01 piece/m^2) treatment, respectively.
17.	Integrated farming system research and development for livelihood improvement in the plain land ecosystem	Farming Research and Development for Livelihood Improvement in the Plain Land Ecosystem" at Tengra village, Sreepur, Gazipur from February 2018. Site characterization for the FSR&D site was done by baseline survey, direct field observation and review of the literature to identify problems for development of packages of technology/agronomic practices and technology validation and intervention. On the basis of problems identified in baseline survey and site characterization, in total 18 activities were undertaken and continued during last two years (Feb. 2018-Jan. 2020) under homestead production system, crops and cropping system, livestock system, fisheries system and plantation system. In total 12 cooperator farm families, four from each category of marginal (0.021-0.2 ha), small (0.21-1 ha), and medium (1.01-3 ha) were selected for intervening farming systems technologies. In crop component, high yielding newly released Aus varieties were introduced in Boro-Fallow-T. Aman and Fallow-Fallow-T. Aman cropping pattern in that region. On-farm demonstrations on newly released BRRI varieties are going on during Aus, Aman and Boro season. Improvement of the existing cropping system through replacement of rice variety and non-rice crops is also going on. In livestock component, turkey rearing under scavenging system seems to be a promising option to increase farmers' income. Pigeon and goat rearing is going on to increase farm

Sl. No.	Research Activities	Progress
		income. Homestead productivity was also increased. On the other hand, farm income as well as consumption of vegetables and livestock products of the farmers' increased significantly. Semi aquatic production system of vegetables, fruits and fish in the derelict pond was highly profitable and farmers are very much interested to this new technology. Other activities like drumstick plantation, utilization of fallow land under orchard, spraying of fruit trees is in progress. Fruit sapling distribution, chewing type sugarcane cultivation at homestead, palmyra seed sowing etc. were also done.

Agricultural Economics Division

Table – 2

Research Progress 2019 – 2020

Sl. No.	Research Progress	Expected output
1	Farm level adoption and evaluation of modern rice cultivation in Bangladesh Objectives: • To determine the region-wise adoption rate of different MVs in Aus, T. Aman and Boro seasons; • To estimate the yield of different modern and local rice varieties in different seasons; and • To determine the socio-economic and varietal constraints to the adoption of MV rice in different regions. Duration: Routine work Research site/ Location: Fourteen Agricultural Regions of Bangladesh Status: Completed	Variety wise adoption rate and yield be delineated; and constraints of MVs be identified.
2	Estimation of Costs and Return of MV Rice Cultivation at the Farm Level Objectives: • Delineate input use pattern in modern Aus, T. Aman and Boro rice cultivation; • Estimate the profitability and risk of modern Aus, T. Aman and Boro rice cultivation at farm level. Duration: Routine work Research site/ location: Fourteen Agricultural Regions of Bangladesh Status: Completed	Profitability, factor and income share of MV rice cultivation be estimated.
3	Value Chain Analysis of Aromatic Rice (BRRI dhan50) at Jashore District in Bangladesh Objectives: • Map the value chain networks of aromatic (BRRI dhan50) rice and the process of value addition along the chain; • Determine cost, margin and price spread of supply chain of aromatic	Efficient and emerging value chain for aromatic rice be identified.

Sl. No.	Research Progress	Expected output
	(BRRI dhan50) rice; and, • Identify constraints and opportunities of value chain of aromatic (BRRI dhan50) rice and recommend policy measures Duration: July, 2019 - June, 2020 Locations: Jashore and Chaugachha Status: Completed	
4	Farmers' perceptions of and adaptation strategies to climate and environmental changes in drought prone north-west Bangladesh Objective: • Delineate farmers' perception of and responses to climate and environmental changes in relation to rice production; • Identify the factors affecting the adaptation strategies; • Estimate economic viability of the dominant cropping pattern; and • Understand farmers' observation along with their suggestions of the impact of climate change on farming; Duration: July, 2017 - June, 2020 Locations: Rajshahi Status: Yearly Report Completed	Farmers' preference about T. Aman rice varieties with their most and least preferred traits be identified.
5	Sustainable Food and Nutritional Security of Smallholder Farmers in Rural Bangladesh through BRRI Developed Technologies Objective: • to evaluate the present food/rice security situation in rural Bangladesh; and • to address the possible ways for increasing rice production/productivity for achieving food and nutritional security in Bangladesh. Duration: July, 2019 - June, 2020 Location: All over Bangladesh Status: Completed	• Present food security situation in Rural Bangladesh be evaluated. • Possible ways for increasing rice productivity be assessed.
6	Returns to Investment on Rice varietal Research in Bangladesh Objective: • Estimate the rate of return of post 1990s BRRI released varieties replacing pre1990s rice varieties. Duration: July 2018- June 2020	• Returns to investment on rice research in Bangladesh be estimated
7	Adoption and Profitability of Modern Rice Cultivation including Nerica in the Hilly areas of Bangladesh Objectives: • To find out the adoption of different rice varieties in different seasons , input use level, yield, profit, and causes of cultivating existing rice varieties; • To explore the reasons of not using recommended inputs, if any; • To find out the existing input –output marketing system in the hilly areas and • To identify problems faced in rice production and suggest probable solution.	Rice cultivation status in the hilly area and problems and opportunities of modern technology adoption will be identified.

Sl. No.	Research Progress	Expected output
	Duration: 2017-2020 Study Locations: Total 10 Upazila (4 from Rangamati, 3 from Banderban and 3 from Khagrachari) from 3 Hilly districts Status: Yearly Report Completed	
8	Migrant Wage Workers Adaptation to Health Risk of COVID-19 Virus in Haor Areas of Bangladesh Objectives: • To delineate migrant labours' health risk management strategies to COVID-19 virus. Duration: July 2019 - June 2020 Study Locations: Netrokona, Kishoreganj and Sunamganj Status: Completed	Health risk of workers being infected with COVID-19 virus while harvesting paddy in Haor areas of Bangladesh be assessed.
9	Impacts of Super Cyclone Amphan and Farmers' Adaptation in Southern Coastal Bangladesh Objectives: • To delineate the impact of Amphan on rice farming and livelihoods of coastal households; • To delineate farmers suggestions for increasing crops production and adaptive capacity. Duration: July 2019 - June 2020 Study Locations: Satkhira, Khulna, Bagherhat and Patuakhali Status: Completed	Impact of Amphan on rice production and rural livelihoods of coastal households be assessed
10	Biophysical and Market Performance of Boro rice in Haor Area in Bangladesh Objectives: • Availability status and contribution of wage workers and power harvester in harvesting Boro rice, • The cost of harvesting Boro rice under manual and mechanical operation and • Biophysical and market performance of Boro cultivars. Duration: July 2019 - June 2020 Study Locations: Netrokona, Kishoreganj and Sunamganj Status: Completed	Availability of labors and Mechanization status during Boro paddy harvesting in Haor areas be assessed
11	Farmers' varietal preferences and product profile in saline ecosystem of Bangladesh Objectives: • To delineate farmers' preferences for developing product profiles that will help to develop future rice varieties in the coastal saline regions of Bangladesh. Duration: July 2019 - June 2020 Study Locations: Satkhira and Khulna Status: Completed	Rice varietal preferences of farmers in coastal regions will be identified.

Agricultural Statistics Division

Table-2

Research Progress 2019-2020

Sl. No.	Research Progress	Expected output
1.	Project: Stability Analysis of BRRI varieties	
	1.1 Experiment: Stability Analysis of BRRI varieties Research Progress: ▪ Updated the database on rice yield (from 2001-02 to 2018-19) of BRRI varieties ▪ T. Aman/2019 znd Boro/2019-20 data collection and analysis already been completed	Stability index of BRRI varieties according to seasons
	1.2 Experiment/Study: Study on G X E interaction of BRRI varieties (In collaboration with Pl. Breeding Div., ARD Regional Stations) Research Progress: ▪ Computer programming for analysis has completed. ▪ T. Aman and Boro season data processing and analysis already been completed.	Genotype x Environment Interaction effect of BRRI varieties
2.	Project: Multivariate Analysis of BRRI Varieties	
	2.1 Experiment/Study: Region specific BRRI variety adoption: A simple way of increasing national rice production Research Progress: ▪ Secondary data already collected from yearbook of Agricultural Statistics-2017, Published by BBS, April-2018 and data analysis has done. ▪ Primary data collection of T.Aus, T. Aman and Boro data processing and analysis already been completed.	Projection of the national rice production of Bangladesh
	2.2 Experiment/Study: Maintenance of rice database Research Progress: ▪ Data is updating continuously & introducing important related data.	1. Database on rice and related crops. 2. Year wise GR of Rice Production in Bangladesh 3. Database on climatic factors 4. Various climatic maps

Sl. No.	Research Progress	Expected output
3	Project: Agro Meteorology and Crop Modeling	

	3.1 Experiment/Study: Minimizing Agro Micro climatological Risk Factors for Maximizing Sustainable Rice Production in Bangladesh *Research Progress:* Daily weather forecasting and validation of the model is going on. Generating agro meteorological advisories based on weather forecasting is running	1. Forecast and validate daily crop weather for sustainable rice production. 2. Technical capacity enriches for crop management and smartly disseminates information of daily weather forecasting and advisories to the farmers.
	3.2 Experiment/Study: Simulating of Climate Change Impact on Rice Growth and Yield in Bangladesh using DSSAT Model (In collaboration with Entomology Div., Plant Physiology Div., Soil Science, IWM Div., Plant Pathology Div., and Agril. Econ. Div.) *Research Progress:* Daily weather forecasting and validation of the model is going on. Generating agro- meteorological advisories based on weather forecasting is running	1. DSSAT model validation for the assessment of climate change impacts on rice varieties released by BRRI. 2. Genetic coefficient of eight BRRI released rice varieties will be estimated. 3. Impact of climate change on rice growth and yield will be identified. 4. Yield of rice varieties will be forecasted. 5. Adaptation options for regional rice farmers will be analysed.
4	Project: Geographical Information System (GIS)	
	4.1 Experiment/Study: Suitability Mapping of BRRI dhan87 to of BRRI dhan89 (In collaboration with Plant Breeding Div., Soil Science Div. and ARD) Research Progress: Suitability Mapping (Edaphic) of BRRI dhan87-89 and BRRI hybrid dhan6 has been completed.	Suitable and not suitable areas for particular rice varieties
	4.2 Experiment/Study: Climate Mapping of Temperature and Rainfall in Bangladesh *Research Progress:* Maps of maximum temperature, minimum temperature and total rainfall 2016and 2017 has been completed.	Different climatic factors maps of Bangladesh.

Sl. No.	*Research Progress*	Expected output
	4.3 Experiment/Study: Rice Crop Mapping using Satellite Remote Sensing Technology in some selected area of Bangladesh *Research Progress:* Temporal signature of various types of rice and others features in barind area were extracted and finally rice map has been prepared.	Rice crop map based on classification (early, late and very late transplanting rice).
	4.4 Experiment/Study: Prospect of Aus rice area of Bangladesh *Research Progress:* ▪ Data collection and analysis already been completed and database were prepared ▪ Highland, medium highland-1 and total agriculture area for Aus (Highland and medium highland-1) were determined ▪ Maps of highland, medium highland-1 and total area for aus have been completed.	Determine mouza wise highland and medium highlan-1 agricultural area for Aus rice in Bangladesh
5.	Project: Capacity Building Through Training *5.1 Experiment/Study:* Training Program on Experimental Data Analysis *Research Progress:* Four types of training was conducted under "experimental data analysis" programme. A total of 150 participants were trained through the training programmes. The participants of these training were scientists, AE and SA of BRRI.	Skills of BRRI scientists on experimental data analysis will be enriched.
6	**Project: Information and Communication Technology (ICT)** **6.1 Activity:** **"Rice Doctor" Apps for BRRI** **Research Progress:** We have developed BRRI Rice Doctor web and mobile apps both Bengali and English language.	Develop and Manage and maintain rice doctor app.
	6.2 Activity: **Mobile Apps of "RKB" (Rice Knowledge Bank)** **Research Progress:** RKB is regularly updating with including all varietal information. It has also included Rice cultivation methods, rice production methods, soil and fertilizer management, insects and their management, diseases and their management and irrigation & water management.	1. Manage and maintain RKB. 2. Extend and update regularly as routine work.

Sl. No.	Research Progress	Expected output
	6.3 Activity: BRKB Website Management Research Progress: ▪ Updated with latest information of Aman, Aus and Boro rice varieties. ▪ All types of information like Soil and fertilizer management, insects and pest management, Rice diseases management and preservation methods have been updated.	1. Provide more benefit to all users specially farmers, extension workers, researchers etc. 2. Include more information as well as national issues associated with rice production and training.
	6.4 Activity: Dynamic view connectivity system, Bangla searching system and inner banner system for BRKB Website (In collaboration with training, breeding and others research divisions) Research Progress: *We have developed dynamic view connectivity system in BRKB.*	1. Dynamic view connectivity system in BRKB. 2. Bangla searching system in BRKB. 3. Inner banner system in BRKB.
	6.5 Activity: BRRI Web Mail and Group Mail Research Progress: ▪ We have created individual e-mail id into BRRI domain for all scientists and all officers as per requirement of MoA. ▪ We have created group mail for all scientists, officers and regional stations as per requirement of BRRI scientists. ▪ We provided 120 webmail solutions in this reporting year. ▪ BRRI Web mail & Group mail has been hosted at BCC (Bangladesh Computer Council) server.	1. Create web mail ID and group mail as per requirement of BRRI scientists and officer's usage. 2. Manage, maintain and update regularly web mail ID, password and group mail for security purpose.
	6.6 Activity: Developing secure system for BRRI Web Mail and Group Mail Research Progress: ▪ Automatic active & close system (AACS) has been developed in BRRI web mail. ▪ In the reporting year we incorporated secure sockets layer system in BRRI web mail, now our web mail is more secure.	1. Spamming filtering system (SFS) in BRRI web mail and group mail. 2. Automatic active & close system (AACS) in BRRI web mail and group mail. 3. Secure Sockets Layer system in BRRI web mail and group mail.

Sl. No.	Research Progress	Expected output
	6.7 Activity: Online Application System of BRRI *(In collaboration with Administration of BRRI and Teletalk Mobile Company Ltd.)* Research Progress: ▪ BRRI already started online application system with the help of Teletalk Bangladesh Limited.	1. Digital and paperless recruitment system for BRRI. 2. Manage and maintain online application system of BRRI.
	6.8 Activity: e-File Management System of BRRI *(In collaboration with Administration of BRRI)* Research Progress: ▪ Started and issued various file, official letter, various notice etc. through e-Filing (Nothi) system at all research division, section and administration of BRRI HQ. ▪ Started various file through e-Filing (Nothi) system initially at Rajshahi and Rangpur Regional Station.	1. Establishing uninerrupt and Paper-less office system. 2. Manage and maintain e-File (Nothi) system of BRRI.
	6.9 Activity: e-Tender System of BRRI Research Progress: ▪ In the reporting year BRRI has been submitted 102 tenders into e-GP Portal in collaboration with procurement cell, building & construction division and others research divisions. ▪ Tender submission process is being continued.	1. Establishing e-Governance. 2. Manage and maintain e-Tender system of BRRI.
	6.10 Activity: Digitalized Labour Salary Management System of BRRI. *(In collaboration with FM Div.)* Research Progress: ▪ We already developed digitalized LSMS for BRRI including labors information, two types of attendance (General attendance and additional attendance), pay slips, allowances, deductions, leave, savings and net pays etc. ▪ Salary management system is easier than previous system for digitization.	Digitalized labour attendance as well as salary system of BRRI. information

Sl. No.	Research Progress	Expected output
	6.11 Activity: Digitalized Casual Leave (CL) Application of BRRI Research Progress: ▪ Software design has been completed. ▪ Architecture of database has been completed. ▪ Application system is running.	Digitalized Casual Leave (CL) Application system for Agricultural Statistics Division

	6.12 Activity: LAN and internet connectivity of BRRI regional station(R/S) Research Progress: ▪ Established Local Area Network (LAN) connectivity at five regional stations i.e. Sonagazi, Comilla, Rangpur, Barisal, and Habigonj. ▪ Increased 2 Mbps full duplex, dedicated and 3.5G (3.5 Generation) internet bandwidth at four regional stations i.e. Rangpur, Sonagazi, Cumilla and Habigonj.	1. Manage and maintain Internet connectivity of BRRI regional station 2. Manage and maintain local Area Network of BRRI regional station.
	6.13 Activity: BRRI Web Portal Management Research Progress: ▪ We have included rice database, climate database etc. at BRRI dynamic website and updated regularly. ▪ To make more updated and informative, we developed individual web page including picture of Headquarter and all regional stations of BRRI.	1. New features for BRRI web portal. 2. To increase hosting spaces gradually.
	6.14 Activity: BRRI Network Updating, maintenance and Extension Research Progress: ▪ BRRI Network is continuing with regular updating posted by everybody of this group. ▪ At present 418 individuals have joined this group.	1. Store more research related activities post and necessary documents. 2. Extend the group with adding more members and introducing more new feature for noble purpose.
	6.15 Activity: Video Conference System of BRRI Research Progress: Already we have created Skype and Zoom account for all divisional head and regional stations head. The communications between BRRI headquarter and other's regional station has been conducted by Video Conference System in every monthly co-ordination meeting now and other meeting.	Creating Skype and Zoom account for all scientists.

Sl. No.	Research Progress	Expected output
	6.16 Activity: Management Information System (MIS) of BRRI Research Progress: Managing and Producing regular reports on operations for every level of management of BRRI	1. Establishing e-Governance. 2. Setup Management Information System (MIS) of BRRI

	6.17 Activity: Integrating Digital Signature with e-File (Nothi) System of BRRI and its management Research Progress: ▪ BRRI Provided 100 update version of Digital Signature Certificate through 4 days long training co-operated by Controller of Certifying Authority (CCA), ICT Division. ▪ The Digital Signature Certificate provided to BRRI scientists and officers for using all types of email, web mail and e-Nothi system.	1. Integrate into e-File (Nothi) system. 2. Update version of digital signature certificate to scientists and class 1 officer at BRRI for using e-File system through proper training 3. e-Governance system through digital signature system at BRRI
	6.18 Activity: Rice Pest Corner Research Progress: We have developed "Rice Pest Corner" with the information of insect & pest management and disease management.	Web application for Rice Pest Corner to identify timely pest problems in rice and control to manage them
	6.19 Activity: Personal Data Sheet of BRRI. Research Progress: ▪ Created Personal Data Sheet (PDS) database including various information field for all scientists, officers, staffs as per requirement of the Ministry of Agriculture (MoA). ▪ We have distributed 339 user ID and password to all scientists, officers & stuffs personal mail and published user id list into BRRI website. ▪ It is a routine work and updated regularly	Creating Personal Data Sheet (PDS) database including various information fields for all scientists, officers, stuffs as per requirement of the Ministry of Agriculture (MoA).
	6.20 Activity: Heritage of BRRI. Research Progress: ▪ We have created Heritage for all retired scientists, officers, staffs and labours of BRRI as per requirement of the BRRI authority. ▪ Heritage is updated regularly as per availability of information. It is a routine work.	1. Managing and maintaining BRRI heritage. 2. Adding all ex. Scientists, ex. officers and ex. Stuffs in BRRI heritage.

Farm Management Division

Table 2

Research Progress 2019-2020

Sl. No.	Research Progress	Expected output
Program area: Socio-economic and Policy		
	3.1. Project: Rice Production Management	
	Expt. 1. Effect of transplanting date and spacing on the yield and yield components of different short duration rice varieties in T. Aman and Boro season. The experiment is in the field. **Progress:** Results of T. Aman 2019 Boro 2019-2020 are being processed.	Early transplanting might be produced better yield for short duration variety
	Expt. 2. Integrated nutrient management for yield maximization of Rice. **Progress:** Results of T. Aman 2019 and Boro 2019-2020 are being processed.	STB dose + 1 t/ha poultry manure may be produced higher yield in both season.
	3.2. Project: Survey and development of data base for labor management	
	Expt. 1. Monitoring the laborers' wages rate for rice cultivation around BRRI Farms. **Progress:** Data collections are being going on	The average wage rate through out the year may higher than last year
	3.3. Project: Management and utilization of land, labour and other resources. • Ten activities were done on seed production, irrigation, drainage, beautification etc. These are the continuous routine activities	These are for the better outcome from farm land and researchers.

Farm Machinery and Postharvest Technology Division

Table - 2

Research Progress 2019-2020

Sl.	Research progress	Expected output
1.	**Programme area /Project title: Development of Agricultural Machineries**	

Sl.	Research progress	Expected output
1.1	***Experiment :*** *Development and fabrication of a whole feed combine harvester* ***Progress:*** ❖ A prototype of whole feed combine harvester was fabricated using locally available materials in the FMPHT divisional workshop, BRRI, Gazipur. ❖ The important functional elements were cutter bar, reel, grain screw conveyer, feeding conveyor, threshing drum, blower fan, paddy screw conveyer and driving power of the combine. The grain holding tank and bagging system were also considerable parameters to design a combine harvester. ❖ First version of the whole feed combine was developed and some problems were identified in the field test. Material selection was not good enough and frequent trouble was observed during field operation. ❖ As per design, specifications, identified problems of the 1st version and recommendations were considered. ❖ The 2nd version of this whole feed combine harvester was fabricated at FMPHT divisional workshop. ❖ Some parts of the machine such as crawler, gear box, hydraulic systems etc. were procured from local market. Maximum parts of the machine were manufactured in the divisional workshop and some of the parts of the machine were fabricated in the local workshop as well. ❖ Initial performance test was done to find out the faults of the machine. After fine tuning, the performance test will be done in upcoming Aman season to find out the performance, efficiency and operational faults.	• Prototype of whole feed combine harvester will be available for Bangladesh condition. • The machine will help to harvest at proper stage of crop maturity and reduce drudgery.
1.2	**Experiment:** Design and development of fertilizer deep placement mechanism for existing rice transplanter **Progress:** ❖ Mixed fertilizer deep placement mechanism was incorporated in the walking (ARP-4UM) and riding type (S3-680) rice transplanter under NATP phase-II sub-project funding. ❖ Both the technologies were improved based on problems identified during field trials in Boro 2018-19 and Aman 2019 seasons. ❖ In both the types of rice transplanters, spiral type mechanism was incorporated as metering device to receive and dispense desired amount of mixed fertilizer. ❖ Engine power of the rice transplanter (1800 rpm) was conveyed to the applicator with the arrangement of a belt-pulley, worm gearing, shaft-bearing, universal joint, and bevel gear with engage-disengage facility resulting 23 rpm of the applicator main shaft. ❖ Fertilizer dispensing rate increased with the increase of number of the lever position. ❖ Developed rice transplanter cum fertilizer applicator (RTFA) was evaluated in the laboratory, soil bin, research field and farmer's field.	• Prototype of prilled urea deep placement mechanism in the mechanical rice transplanter will be available for Bangladesh condition. • Losses of fertilizer in different form (Leaching, ammonia volatilization, de-nitrification and surface runoff) will be

Sl.	Research progress	Expected output
	❖ In the lab test, it was found that fertilizer control lever can control fertilizer dispensing rate according to pre-calibration. ❖ Agitator, which was used in the fertilizer hopper, rotated smoothly to prevent the bonding of fertilizer mixture. ❖ In the soil bin test, it was observed that mixture fertilizer dispensed uniformly in the furrow and covered effectively.	reduced.
1.3	***Experiment:*** *Field evaluation of the BRRI rice transplanter cum mixed fertilizer applicator* **Progress:** ❖ A research was conducted to evaluate the field performance of the BRRI rice transplanter cum mixed fertilizer applicator (RTFA) in different locations during Boro and Aman season. ❖ RCB design was followed in both the seasons with three replications. In Boro 2018-19 season, average dispensing rate of fertilizer in lever position 4 was calibrated 67.94 g/rotation of the rice transplanter driving wheels; while average deviation in fertilizer dispensing rate was found +3.72% due to clog of the dispensing channel during operation. ❖ The theoretical and actual field capacity and field efficiency of the RTFA were found 0.20 ha/h, 0.0.12 ha/h and 58.95% while it was 0.20 ha/h, 0.13 ha/h and 64.10% of the rice transplanter without fertilizer deep placement mechanism respectively in Boro season. ❖ During field trials in Aman 2019 season, average dispensing rate of fertilizer in lever position 3 was calibrated 37.8 g/rotation of the rice transplanter driving wheels; while average deviation of fertilizer dispensing rate was about -4.86% due to slippage of the wheels. ❖ In an average of seven trials in Aman season, theoretical and actual field capacity and field efficiency of the RTFA were found 0.19 ha/h, 0.23 ha/h and 82.2% while it was 0.21 ha/h, 0.26 ha/h and 80.3% of the rice transplanter without fertilizer deep placement mechanism respectively. ❖ It was observed that grain yield varied with the mode and rate of fertilizer application in Aman 2019 season.	• Rice transplanter cum mixed fertilizer applicator will be validated for Bangladesh condition. • Farmers can apply prilled urea fertilizer or mixing of Urea, TSP, MoP and Gypsum fertilizer along with seedlings transplanting using the same machine. • Losses of fertilizer in different form (Leaching, ammonia volatilization, de-nitrification and surface runoff) will be reduced.
1.4	***Experiment :*** *Design and development of walking type power operated rice transplanter* **Progress:** ❖ A study was conducted to develop a walk behind type power operated rice transplanter in the FMPHT divisional research workshop. ❖ Power transmission system was analyzed to design different gears (worm, bevel, spiral bevel, spur), pulley, chain-sprocket, rotary picker, seedling releaser etc. ❖ Jigs and fix also fabricated for the different components of the transplanter for ease of replications. ❖ Fabrication drawing of the different components is under process.	• Prototype of walk behind type power operated rice transplanter will be available for Bangladesh condition • Farmers will save time and costs for

Sl.	Research progress	Expected output
		transplanting
1.5	***Experiment :*** *Design and development of a head feed power thresher* **Progress:** ❖ A study was undertaken to design and development of a head feed thresher using locally available materials. ❖ BRRI provided design, drawing, technical and financial support to develop and fabricate this machine. The machine has already manufactured by this local workshop. ❖ Preliminary test of the machine was done in Boro 2020 season to find out its mechanical faults. ❖ It was found that the machine has no major faults. ❖ Fine-tuning of this machine is going on. The performance test of the machine will be done thoroughly in the upcoming season.	• Prototype of head feed power thresher will be available for Bangladesh condition • Bundle of paddy can be threshed by this machine.
1.6	***Experiment :*** *Performance evaluation of battery operated reaper* **Progress:** ❖ A battery operated small size reaper was developed in Zomzom workshop, Pabna. ❖ The machine consists of main body, power transmission system and cutter bar. ❖ The machine was tested at the farmers' field in Pabna. ❖ The wide of the cutter bar was 45 cm. The average forward speed of the machine was 2.8 km/h and capacity was 0.09ha/h.	Battery operated reaper will be validated for Bangladesh condition.
1.7	***Experiment :*** *Determination of tilling efficiency of power tiller at selected areas of Bangladesh* **Progress:** ❖ The effects of tillage depths on the productivity of paddy were determined in field experiments in Aman 2019 and Boro 2020 at BRRI RS, Rajshahi and Rangpur in different tillage depths. ❖ There were five tillage depths i.e. 2-3, 3-4, 4-5, 6-7 and 7-8 inches. Tillage depths affected tiller, panicle number and yield of BRRI dhan34 in Aman 2019, BRRI dhan28 at Rajshahi and BRRI dhan63 at Rangpur in Boro 2020 season. ❖ Tiller and panicle number of plant also increased with the increase of tillage depth. These were found highest in 6-7 inches depth of tillage and nearly same as 7-8 inches depth of tillage. ❖ The highest grain yield was found 2.50 t/ha and 5.18 t/ha in the tillage depth of 6-7 inches and lowest yield was found 2.02 t/ha and 4.00 t/ha in the tillage depth of 2-3 inches in Aman 2019 and Boro 2020 respectively at BRRI RS Rajshahi. ❖ At Rangpur the highest grain yield was found 8.05 t/ha in the tillage depth of 7-8 inches and the lowest yield was found 7.33 t/ha in the tillage depth of 2-3 inches and at 6-7 inches the yield was found 7.99 t/ha. ❖ Number of tiller, panicle, and yield of both the varieties were found more or less same in both the seasons at 6-7 and 7-8 inches tillage depth. Farmers of Bangladesh practiced usually 4-5 inches depth of tillage for paddy cultivation.	Tilling efficiency of power tiller will be defined at selected area of Bangladesh

Sl.	Research progress	Expected output
1.8	***Experiment:*** *Survey on status and constraint of farm machinery used in farmer's field at selected areas.* **Progress:** ❖ A survey was conducted using semi-structured questionnaire on machinery used in farmer's field at Botiakhali and Hazratala in Sreepur upazila of Magura district. ❖ A number of machinery were used in these villages and these were power tiller, shallow tube well, engine operated pedal thresher and sprayer. ❖ There were no rice transplanter, reaper, combined harvester at the farm level of these areas. So, there is a scope to introduce this machinery in these areas. ❖ The problem was that the operator of the machine is not skilled and they never follow proper machinery maintenance schedule which increase their operation time and repair cost. So, proper training should be arranged for the machinery operator.	The status and constraints of farm machinery using scenario of selected areas will be known.
1.9	***Experiment:*** *Potentiality of engineering workshop for enhancing farm mechanization in selected areas* **Progress:** ❖ A survey was conducted on potentiality of engineering workshop for enhancing farm mechanization in Rangpur district by the developed semi-structured questionnaire. ❖ Different kinds of farm machinery have been used in the farmers' field. Some of them were imported and the rest was made by the local workshops. ❖ The facilities of machinery of the workshops were lathe, shaper, drill, grinding and welding machine.	The potentiality of local engineering workshop will be identified for farm mechanization.
2	***Project Title: Milling and Processing Technology***	
2.1	***Experiment :*** Study the effect of polishing on rice grains quality **Progress:** ❖ The aim of this study was to determine the percentage of milling effect on weight loss, head rice recovery, and zinc (Zn) loss of rice at Farm Machinery and Postharvest Technology (FMPHT) Division, BRRI, Gazipur. ❖ Three most popular rice varieties such as BRRI dhan28 (not Zn enriched), BRRI dhan42 and BRRI dhan74 (Zn enriched bio-fortified) were used to conduct the study. In this study, grain Zn content was estimated in the brown rice (de-husked unpolished grain) and different degrees of polished rice (7.5, 10, 12, 13.75 and 15%) by the atomic absorption spectrophotometer (AA-7000). ❖ It was carried out in randomized complete block (RCB) design with three replications. It was observed that the zinc content of the three varieties decreased with the increasing of the degree of milling (DoM). ❖ It was revealed that there had negative relationship between DoM and head rice yield. The zinc content of the three varieties was varied up to 12% DoM and after 13.75% DoM there have no difference in	The percentage of milling effect on weight loss, head rice recovery and zinc content will be determined of BRRI dhan28, BRRI dhan42 and BRRI dhan74 variety.

Sl.	Research progress	Expected output
	Zn content, both bio-fortification and not Zn enriched varieties. ❖ During the milling process, the broken percentage increases with increasing of DoM, due to low surface hardness which leads to low quality and recovery of milled rice. ❖ The DoM affects not only the quality but also the appearance of rice kernels. The whiteness value of each variety was the lowest in the brown rice stage, followed by different degree of milling (7.5<10.0<12.0<13.75<15%) in both parboiled and un-parboiled condition. ❖ This study showed that the DoM and whiteness are positively correlated. It can be concluded from these results that over DoM affect the losses of Zn content as well as lower head rice yield. It was clearly shown that more food loss occurred due to more degree of milling, which is greatly, hampered the food security of the nation.	
2.2	***Experiment :*** *Design and development of a small scale recirculating type dryer* **Progress:** ❖ The experiment of recirculating dryer was conducted during Boro season 2020 at the FMPHT divisional workshop using BRRI dhan28 with different load capacity. ❖ The modified dryer was run in no load, half load and full load condition. Drying air temperature distribution through grain bin was uniform throughout the dryer during drying operation. ❖ The paddy was dried from 28.7 to 18.9%, 28.5 to 14.2% and 29.4 to 13.6% during Boro season 2020 within the range of 4.5 to 10.0 hrs. respectively. ❖ The drying rate was found to be varied between 1.6 to 2.2% which directly depends on initial moisture content of paddy and drying air temperature. The range of drying efficiency was ranged from 24.9% to 51.6% during Boro season for different dryer capacity.	Small scale recirculating type dryer will be available for the end users.
2.3	***Experiment :*** *Test, evaluation and modification of rubber roll de-husker and MNMP-15 type polisher* **Progress:** ❖ FMPHT Division modified rubber roll de-husker for improving the performance of rice processing. ❖ Husking efficiency of modified rubber roll de-husker was around 90% for BRRI dhan84. Milling recovery of BRRI dhan84 was 64 % polished in MNMP - 15 type polisher followed by de-husking. ❖ The average head rice recovery based on input paddy was 54.0 %, which is promising for processing of premium quality rice. ❖ Engelberg huller may replace with one rubber roll de-husker and polisher for better quality rice. ❖ Beside this, rubber roll de-husker separate husk and friction type polisher separate bran. ❖ Separately collected husk and bran is suitable for briquette and edible oil production.	Improved rubber roll de-husker will be developed for small scale rice milling.

Sl.	Research progress	Expected output
2.4	***Experiment :*** *Study on milling recovery of BRRI dhan71 under different moisture content* **Progress:** ❖ Parboiled BRRI dhan71 with six different moisture contents was processed in the air blow type engelberg huller to find out the optimum moisture content of milling. ❖ Milling yield for moisture content of 9.1%, 10.2%, 11.3%, 12.3%, 13.2% and 13.9% (Wet basis (wb)) were found 67.5%, 68.0%, 68.6%, 69.2%, 70.0% and 70.5% respectively and head rice recovery (based on input paddy) were 59.0%, 63.0%, 62.5%, 60.0%, 58.8% and 56.6% respectively. ❖ Higher head rice recovery was observed in 63.0% and 62.5% in 10.2% and 11.3% moisture content (wb) respectively. Broken rice percentage (based on input paddy) was found lower (5.0%) in 10.2% moisture content (wb). ❖ It may be concluded that, around 10-11% moisture content (wet basis) is suitable for milling of parboiled paddy processed in the air blow type engelberg huller in terms of head rice recovery and less broken percentage.	The milling recovery of BRRI dhan71 will be defined
3	***Project Title: Industrial And Farm Level Extension Of BRRI Machinery***	
3.1	***Experiment:*** *Custom hire service business of rice combine harvester in haor basin of Bangladesh* **Progress:** ❖ A study was conducted in haor ecosystem of Bangladesh to investigate the rental charges and operational management of the combine harvester in a competitive way. ❖ The data collected in Mithamain upazila under the Kishoreganj district covering haor region of Bangladesh from 86 rice fields, harvested by the whole-feed combination of harvesters (Model: Zoomlion). ❖ The size of land, operative time, loss time, repair time and idling time were also recorded to predict the business sustainability of combined harvester. ❖ Daily area coverage and harvester constraints were also recorded. In keeping with the standard protocol, the renting and payback period is determined to make businesses profitable. It was found that the combine harvester becomes profitable only after 40 hectares of paddy field harvested at a harvesting capacity of 0.20 ha h-1 for the rental charges of Tk 10,000 ha-1.	Rental charges and operational management will be investigated.

Workshop Machinery and Maintenance

Table-2

Research Progress 2019-20

Sl. No.	Research Progress	Expected output
1	Design, development, and modification of self-propelled reaper Progress: The complete design of self-propelled reaper has been done with the help of AutoCAD. Fabrication of the reaper is going on at BRRI Research Workshop. Test and evaluation of self-propelled reaper will be done at field level.	Self-propelled reaper will be developed and tested. Harvesting time, cost, human drudgery and yield loss will be minimized.
2	Design and development of motor operated small size reaper Progress: The complete design of motor operated reaper has been done with the help of AutoCAD. Fabrication of the reaper was completed at Zomzom Workshop, Pabna. It has been tested at farmer's field Pabna.	Harvesting time, cost, human drudgery and yield loss will be minimized.
3	Determination of tilling efficiency of power tiller at selected areas of Bangladesh Progress: Experiments are being conducted in Boro and Aman seasons to determine paddy yield as influenced by different tillage depths (2-3 inch, 3-4 inch, 4-5 inch, 6-7 inch and 7-8 inch). It will also be tested in different places.	Optimum tillage depth for maximum paddy yield will be determined in different areas.
4	Potentiality of engineering workshop for enhancing farm mechanization in selected areas of Bangladesh Data was collected from the engineering workshop Rangpur.	Facility and Problem faced by workshop owner is identified. To solve the identified problems the quality of the workshops can be improved.
5.	Survey on status and constraint of farm machinery used in farmer's field at selected areas Progress: Data were collected from 2 villages of Magura district. It will be continued.	Disseminate the benefit of proper farm machinery over traditional method based on the investigation results.
6.	Feasibility study of solar energy use in agricultural machinery Photovoltaic system consists of 850 W solar panel were installed at BRRI automobile workshop to operate BRRI thresher & winnower. Motor of 1 hp was used as power transmission system. Its performance was evaluated in Boro and Aman season 2019.	Using renewable to replace conventional fossil fuels can prevent the release of pollutants into the atmosphere and help combat global warming.

Adaptive Research Division

Table-2
Research Progress 2019-2020

A. TECHNOLOGY VALIDATION

1. Title: Advanced Lines Adaptive Research Trial (ALART)

Sl. No.	Research Progress	Expected output/Output
Program area/Project		
1.1	**ALART, T. Aus 2019:** Three BRRI released Broadcast Aus rice varieties i.e., BRRI Dhan42, BRRI Dhan43 and BRRI dhan83 along with BRRI dhan48 as checks were tested at farmers' field in ten locations under T. Aus ecosystem. The tested BRRI released B. Aus varieties i.e., BRRI dhan42 and BRRI dhan43 gave lower yield than the check variety BRRI dhan48 and they don't have any special characters over the check variety (Table 1). On the other hand, the tested variety BRRI dhan83 gave similar yield with almost similar growth duration to that of check variety BRRI dhan48 and it was lodging tolerant in all the locations. Phenotypic acceptance of BRRI dhan83 was also better than the other tested varieties. Disease infection in BRRI dhan83 was found lower than the other varieties.	Considering Phenotypic acceptance, disease reaction and farmers' opinion, the tested B. Aus variety BRRI dhan83 was recommended for further trial as T. Aus variety in PVT.
1.2	**T. Aman 2019, ALART, Rainfed lowland rice (RLR):** Four advanced lines: BR8521-30-3-1, BR8441-38-1-2-2, BR8526-38-3-2-1-HR2 and BR8526-38-3-2-1-HR8 along with BRRI dhan49 (Ck) and BRRI dhan87 (Ck) as checks were tested at farmers' field in ten locations. The average yield performances (4.13-5.00 t/ha) of the tested advanced lines were significantly lower than the check variety BRRI dhan87 (5.57 t/ha). Although, yield performance of BR8521-30-3-1 was similar to BRRI dhan49 and grain size was fine and 1000-grain weight was less than the all other genotypes, it was not considered for PVT for its slightly irregular flowering and maturity. Moreover, all the tested entries had the same irregularity problem.	Considering all the necessary characteristics and farmers' opinion, no advanced line was found suitable for PVT.
1.3	**T. Aman 2019, ALART, Zinc Enriched rice (ZER):** Three zinc enriched advanced rice genotypes BR8436-7-4-2-3-1, BR8442-12-1-3-1-B7, IR90210-100-2-3-1-P4 along with BRRI dhan49, BRRI dhan72 and BRRI dhan87 as checks were tested at farmers' field in nine locations. Check variety BRRI dhan87 produced higher grain yield than the other check varieties and the tested advanced lines (Table 3). BR8442-12-1-3-1-B7 produced similer yield with other two ckeck varieties BRRI dhan49 and BRRI dhan72. However, the growth duration of	Considering overall performance, yield, duration, grain type; farmers did not prefer any of the tested lines over BRRI dhan87. So, none of the tested entries was found suitable for proposed varietal trial (PVT).

Sl. No.	Research Progress	Expected output/Output
	BR8442-12-1-3-1-B7 had no advantage over the checks. Growth duration of tested entry no 1 and 3 was lower than three check varieties but yield was lower and flowering was irregular.	
1.4	**T. Aman 2019, ALART, Rainfed lowland Rice (RLR), Biotechnology, (RLR-Bio):** Two advanced lines developed by Biotechnology Division of BRRI for rainfed lowland rice ecosystem i.e., BR(Bio)9786-BC2-161-1-2, BR(Bio)9786-BC2-80-1-1 along with BRRI dhan71 and BRRI dhan87 as checks were tested at farmer's field in ten locations. Although, mean grain yield of BR(Bio)9786-BC2-161-1-2 was statistically similar with the check variety BRRI dhan71. The advanced line BR(Bio)9786-BC2-80-1-1 performed the lowest among the tested entries. The mean growth duration of BR(Bio)9786-BC2-161-1-2 and BR(Bio)9786-BC2-80-1-1was found four and two days earlier than the check variety BRRI dhan87. But mean growth duration of the two advanced lines were 2-4 days higher than the another check variety BRRI dhan71.	Considering the above results and phenotypic acceptance, grain type, disease reaction, insect infestation, lodging tendency, and farmers' opinion, none of the advanced lines was found suitable for PVT.
1.5	**T. Aman 2019, ALART, Rainfed lowland Rice (RLR), Rangpur, (RLR-Rang):** Two advanced lines: BR8189-10-2-3-1-5, BR10238-5-1 along with BR11 (CK) as check were tested in seven locations of greater Rangpur region and BRRI Gazipur. On an average of eight locations, the check variety BR11 gave a little bit higher yield (4.95 t/ha) than the tested two entries BR10238-5-1 and BR8189-10-2-3-1-5 (4.91 and 4.57 t/ha) (Table 5). However, the yield of above three entries was statistically similar to each other. The mean growth duration of the advanced line BR8189-10-2-3-1-5 (entry no.1) was 142, ranged from 128 to 147 days. Whereas, the mean growth duration of another advanced line BR10238-5-1 (entry no.2) was 146 days, ranged from 133-151. Check variety BR11 was found to be matured within the earliest mean growth duration (139 days). Compared to check variety BR11, farmers did not show interest about the advanced lines.	Based on overall performances and farmers' preference, none of the genotypes was found suitable for proposed variety trial (PVT).

Sl. No.	Research Progress	Expected output/Output
1.6	**Boro 2020, ALART Premium Quality Rice (PQR):** Two advanced lines: BR8862-29-1-5-1-3 and BR8995-2-5-5-2-1 along with BRRI dhan50 as check were tested at farmers'field in ten locations. The tested genotypes have no advantages in respect of yield and duration over the check variety BRRI dhan58. Flowering and maturity of the genotypes were irregular. Higher pest incidence was found in the genotypes. Moreover, Grain shape, size and 1000-grain weight of the genotypes were not superior to the check varieties BRRI dhan50.	Based on overall performances, the tested genotypes of PQR were not recommended for proposed variety trial (PVT).
1.7	**Boro 2020, ALART Zinc Enriched Rice (ZER):** One zinc enriched advanced rice genotype IR99285-1-1-1-P2 along with BRRI dhan29 and BRRI dhan84 as checks were tested at farmers' field in ten locations. On an average of ten locations, the entry IR99285-1-1-1-P2 gave higher yield (7.37 t/ha) than the zinc enriched check variety BRRI dhan84 (5.94 t/ha) and it was statistically similar to that of check variety BRRI dhan29 (7.43 t/ha) .Mean growth duration of the advanced line was two days earlier than the check variety BRRI dhan29. Besides, uniformity of flowering and maturity were observed in the advanced line IR99285-1-1-1-P2. Grain type of the line is long slender and it was zinc enriched.	Considering all the above characteristics and farmers' opinion, the entry IR99285-1-1-1-P2 was recommended for PVT.
1.8	**Boro 2020, ALART Insect Resistant Rice (IRR):** One advanced rice genotype BR8340-5-6-1, resistant to BPH along with BRRI dhan58 (Ck) and T27A (R. Ck) were tested at farmers' field in ten locations. The Average yield of the entry BR8340-5-6-1 was lower than the standard check BRRI dhan58. No significant difference was observed in case of insect's infestation and disease incidence. Moreover, all tested genotypes were infested by Brown Plant Hopper (BPH) in two experimental sites of Tarash and Sirajganj upazila in Sirajganj district. All replications of Tested entry BR8340-5-6-1 was damaged by rats about 10-60% in Tarash and Royganj upazila under Sirajganj districts. No other advantages were observed in entry BR8340-5-6-1 compared to check variety BRRI dhan58.	Considering all the above characteristics, the entry BR8340-5-6-1 was not found suitable for PVT.
1.9	**Boro 2020, ALART Blast Resistant Rice (BRR):** Three advanced lines: HR(Path)-11, Path2441 and BR(Path)12452-BC3-16-19 along with BRRI dhan58 and BRRI dhan29 as standard checks were tested at farmers' field in ten locations. On an average, none of the tested lines showed yield advantage over the check varieties. All of the tested lines as well as check varieties were prune to diseases. Though entry no.1 HR (Path)-11 was less susciptible to Blast disease, it was more susceptible	Considering yield, growth duration and disease reactions, none of the tested lines found suitable for PVT.

Sl. No.	Research Progress	Expected output/Output
	to bacterial disease. Moreover, due to its taller plant height HR (Path)-11 became more prune to lodging.	
1.10	**Boro 2020, ALART Bacterial Blight Resistant Rice, Plant Breeding (BBRR-PB):** Two advanced lines: BR8938-19-4-3-1-1-P2-HR3 and BR9651-15-2-1-4 from Plant Breeding division along with BRRI dhan28 (Sus Ck) and BRRI dhan58 (Std Ck) were tested at farmers' field in ten locations. The entry BR8938-19-4-3-1-1-P2-HR3 gave a little higher yield compared to both the standard checks was less susceptible to bacterial leaf blight disease. Growth duration of the entry BR8938-19-4-3-1-1-P2-HR3 (150 days) was 3 days longer than BRRI dhan28 (147 days) but 6 days earlier than BRRI dhan58 (156 days). Grain type is attractive like BRRI dhan28. In maximum cases, farmer, scientists and SA/SAAO chose the entry BR8938-19-4-3-1-1-P2-HR3 as their first choice.	Considering all the above characteristics, the entry BR8938-19-4-3-1-1-P2-HR3 could be recommended for PVT.
1.11	**Boro 2020, ALART Bacterial Blight Resistant Rice, Biotechnology (BBRR-Bio):** Two advanced lines: BR(Bio)11447-1-28-14-3 and BR(Bio)11447-3-10-7-1 from Biotechnology division along with BRRI dhan28 (Sus Ck) and BRRI dhan58 (Std Ck) were tested at farmers' field in ten locations. Though the entries showed resistance over BLB in some extent, the tested entries gave much lower yield compared to the BRRI dhan58 as well as slightly irregular flowering and maturity.	Considering all the above characteristics, no entry of BBRR was recommended for PVT.

B. Technology Dissemination

2. Title: Seed Production and Dissemination Program (SPDP) of BRRI varieties with other technologies under GOB and Projects (SPIRA, TRB**).**

SL No.	Research Progress		Expected Output/Output
	Program area/Project		
SN	**Expt. Title:**	**Locations and**	

	Seed Production and Dissemination Program (SPDP)	**varieties/technologies**	Total production through demo (ton)	Seeds retained by farmers (ton)	Farmers gained awareness through demo (no.)	Motivated Farmer (no.)
2.1	SPDP during T. Aus 2019 under GoB	Locations: 12 upazila in 6 districts: Norsingdhi, B. Baria, Sylhet, Chattogram, Chuadanga and Barguna. Varieties:BRRI dhan27, BRRI dhan48, BRRI dhan82 and BRRI dhan85	19.98	3.95	3832	1223
2.2	SPDP in Jhum during Aus 2019 under HNRP:	Locations: 6 upazila in three hilly districts Khagrachari, Bandarban and Rangamati. Varieties: BRRI dhan48 & BRRI dhan83	0.74	.33	660	185
2.3	Adaptive trial (AT) in Jhum during Aus 2019 under HNRP	Locations: 6 upazila in three hilly districts Khagrachari, Bandarban and Rangamati. Varieties: BRRI dhan27, BRRI dhan48, BRRI dhan82 and BRRI dhan85	BRRI dhan48 and BRRI dhan82 might be suitable for hilly areas.			
2.4	SPDP during the season T. Aman, 2019 under GoB	Locations: 25 upazilas of 12 districts Varieties: BRRI dhan49, BRRI dhan70, BRRI dhan71, BRRI dhan72, BRRI dhan75, BRRI dhan76, BRRI dhan79 and BRRI dhan87	46.11	7.64	6880	1840
2.5	SPDP during the season T. Aman, 2019 at Tangail as a special activity	Locations: Dhanbari and Madhupur upazilas of Tangail district Varieties: BR22, BR23, BRRI dhan71, BRRI dhan72, BRRI dhan75 and BRRI dhan87	46.73	5.13	6937	1213
2.6	SPDP of BRRI dhan 71 and 75 in T. Aman-Potato-Boro Cropping pattern during	Locations: 7 upazilas of 4 district Nilphamari, Joypurhat, Bogra and Thakurgoan Varieties: BRRI dhan71, BRRI dhan75	9.56	2.08	1869	398

SL No.	Research Progress		Expected Output/Output			
	Program area/Project					
SN	Expt. Title: Seed Production and Dissemination Program (SPDP)	Locations and varieties/technologies	Total production through demo (ton)	Seeds retained by farmers (ton)	Farmers gained awareness through demo (no.)	Motivated Farmer (no.)
	Aman, 2019					
2.7	SPDP during the season T. Aman, 2019 under SPIRA	Locations: 9 upazila in 6 districts Tangail, Gaibandha, Jashore, Naogaon, Patuakhali and Bagerhat Varieties: BRRI dhan52, BRRI dhan71, BRRI dhan72, BRRI dhan73, BRRI dhan75, BRRI dhan76, BRRI dhan80 and BRRI dhan87	29.9	3.88	1850	747
2.8	SPDP in valley of hill during T. Aman 2019	Locations: 6 upazilas in three hilly districts (Bandarban, Rangamati & Khagrachari) Varieties: BRRI dhan49 and BRRI dhan87	7.8	1.01	1225	250
2.9	Adaptive trial (AT) in valley during T. Aman, 2019	Locations: three hilly districts (Bandarban, Rangamati & Khagrachari) using five high yielding modern T. Aman rice varieties : BRRI dhan71, BRRI dhan72, BRRI dhan75, BRRI dhan80 and BRRI dhan87	Among the varieties, BRRI dhan87 yielded the highest (5.25 t ha-1) followed by BRRI dhan80 (4.31 t ha-1) with similar growth duration (126 days). These varieties might be suitable for hill areas in T. Aman season. Rice varieties in most of the locations were affected by sheath blight disease. BRRI dhan72 were mostly affected one.			
2.10	Head to Head Adaptive Trial Aman 2019 under TRB project	Locations: A total of 200 HHAT were conducted under TRB project through public private partnership (PPP) in T. Aman 2019 throughout the country. Varieties BRRI released ten varieties: BRRI	Performances of the varieties varied from location to location due to environmental effect. Among the varieties, BRRI dhan87 gave the highest mean grain yield (6.02 t ha-1) while the lowest (4.53 t ha-1) was BRRI dhan73. The preferences of the varieties were BRRI dhan87> BRRI dhan71> BRRI dhan75> BRRI dhan52> BRRI dhan76> BRRI dhan79> BRRI dhan80> BRRI dhan49> BRRI dhan73. Moreover, the farmer's preference			

SL No.	Research Progress		Expected Output/Output			
	Program area/Project					
SN	Expt. Title: Seed Production and Dissemination Program (SPDP)	Locations and varieties/technologies	Total production through demo (ton)	Seeds retained by farmers (ton)	Farmers gained awareness through demo (no.)	Motivated Farmer (no.)
		dhan49, BRRI dhan52, BRRI dhan71, BRRI dhan72, BRRI dhan73, BRRI dhan75, BRRI dhan76, BRRI dhan79, BRRI dhan80 and BRRI dhan87	varied from environments to environment.			
2.11	SPDP during the season Boro, 2020 under core program	Locations: 36 upazila of 15districts Varieties: BRRI dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan81, BRRI dhan84, BRRI dhan86, BRRI dhan88 and BRRI dhan89	30.23	12.99	11010	1358
2.12	SPDP during the season Boro, 2020 under the TRB project	Locations: 24 upazila of 17 districts Varieties: BRRI dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan81, BRRI dhan84, BRRI dhan86, BRRI dhan88 and BRRI dhan89	101.56	122.53	11585	1595
2.13	SPDP in valley of Hill in Boro 2020 under HNRP	Locations: Three hilly districts of Bangladesh (Bandarban, Rangamati, Khagrachari) Varieties: varieties BRRI dhan58, BRRI dhan67, BRRI hybrid dhan3 and BRRI hybrid dhan5	9.72	1.44	281	45

SL No.	Research Progress		Expected Output/Output			
	Program area/Project					
SN	Expt. Title: Seed Production and Dissemination Program (SPDP)	Locations and varieties/technologies	Total production through demo (ton)	Seeds retained by farmers (ton)	Farmers gained awareness through demo (no.)	Motivated Farmer (no.)
2.14	Head to Head Adaptive Trial Boro 2020 under TRB project	A total of 200 HHATs were conducted in throughout the country during Boro 2020 under TRB project through PPP Varieties: BRRI dhan28, BRRI dhan58, BRRI dhan67, BRRI dhan81, BRRI dhan84 & BRRI dhan86, BRRI dhan29, BRRI dhan58, BRRI dhan89 and BRRI dhan92	BRRI dhan88 and BRRI dhan92 showed potentiality throughout the country for BRRI dhan28 and BRRI dhan29 growing areas, respectively. BRRI dhan89 produced competitive yield along with BRRI dhan29, however some famers disappointed for its medium bold grain compared to BRRI dhan29 and BRRI dhan92. BRRI dhan67 also found suitable for throughout the country although it was released for coastal saline environment. BRRI dhan58 and BRRI dhan81 would be suggested to grow in northwest to northern region as these varieties were highly infected by neck blast disease in other regions of the country.			
2.15	Production of quality seeds at BRRI farm	Seeds of recent and promising rice varieties were produced in T. Aman and Boro seasons during the reporting period under the close supervision of Adaptive Research Division	A total of 7.0 tons quality seeds of different BRRI varieties were produced. The seeds were distributed to the farmers and stakeholders through Head to Head Adaptive Trial (HHAT), Seed production and dissemination program (SPDP) and seed support program in next Aman and Boro season.			
Grand Total			**302.33**	**50.98**	**46129**	**9054**

SPIRA=Strengthening Physical Infrastructure and Research Activities of BRRI
TRB= Transforming Rice Breeding Project

C. Promotional activities

Farmers' training and field Day

SN	Farmers' training and promotional activities	Expected Output/Output
3.1	**Farmers training during 2019-20 under GoB, TRB and SPIRA** During the reporting period, ARD conducted 91 farmers' training on "modern rice production technologies" at different locations under GOB	A total of 2730 trainees including farmers and SAAOs of DAE participated

SN	Farmers' training and promotional activities	Expected Output/Output
	and different projects	
3.2	**Field Day/ Farmer's Rally under GoB, TRB, and SPIRA** ARD conducted 50 field days at different locations of the country under GoB and different projects (SPIRA, TRB) during Aus 2019, Aman 2019 and Boro 2020.	About 7000 participants including farmers, local leaders and DAE personnel were participated in the field days.
3.3	**Seed support to stakeholders under TRB project.**	ARD distributed 3.15 and 3.35 ton truthfully labeled seeds (TLS) of 24 modern rice varieties in Aman 2019 and Boro 2020 among farmers and stakeholders with free of cost through seed support program.
3.4	**Establishment of Farmers seed center under TRB project and ASRS program under MoA** Two farmers' seed centers were established at Gaibandha Sadar and Palashbari.	ARD provided 6 plastic drum under TRB project and ASRS program. Around 80 kg seeds can be preserved in each drum. Farmers will preserve good quality seed of promising rice varieties for rapid dissemination through seed exchange or selling among the farmers.

Training Division

Table-2

Research Progress 2019-20

Sl.No.	Research Progress	Expected Output
	Program Area: Technology transfer Program Performing Unit: Training division	
	1. Capacity Building and Technology transfer	
	1.1. Modern Rice Production Training for ACI Employee Duration: 1 week Batch: 1 No. of Participant:20 Progress: Completed	Knowledge of the participants on modern rice production will be enriched
	1.2. Training on Rice Grain Quality Analysis for ACI Officers Duration: 2 weeks Batch: 1 No. of Participant: 10 Progress: Completed	The participants will be able to analyze different aspect of rice grain quality in their laboratory individually.
	1.3.Training on Agricultural Research Methodology for BRRI Scientists Duration: 1 week	The scientists of BRRI will be capable to do research more effectively.

Sl.No.	Research Progress	Expected Output
	Batch: 2 No. of Participant: 49 Progress: Completed	
	1.4.Training on Rice Physiological Development through Trait Discovery for BRRI Scientists Duration: 1 week Batch: 1 No. of Participant: 28 Progress: Completed	Knowledge of the trainees on different traits related to rice physiology will be increased.
	1.5. Modern Rice Production Training for SAAO (Regular) Duration: 1 week Batch: 9 No. of Participant: 178 Progress: Completed	Knowledge of the participants on various aspect modern rice production will be enriched
	1.6. Two months Rice Production Technologies Training course for DAE Officers Duration: 2 months Batch: 2 No. of Participant: 60 Progress: Completed	Trained personnel will be able to acts as master trainier for SAAO and farmers. They can also identify field problems of rice production effectively and solve the problem.
	1.7. Training on Rice Production and Ecofriendly pest control management for SAAO Duration: 1 week Batch: 1 No. of Participant: 20 Progress: Completed	Knowledge of the participants on environment friendly pest management system will be enriched
	1.8. Evaluation of imparted training program	It will help to the management of training division to redesign the training program according to the needs of the trainee.

Regional Station, Sagardi, Barishal

Table – 2

Research Progress 2019-20

Sl#	Research Progress	Expected output
Programme area/Project with duration: Regional Station, 2019-20		
1	**Varietal development**	
	i) **Development of Tidal Submergence Tolerant Rice:** In objective to develop improved varieties for tidal submergence ecosystem, 48 new crosses are made, 452 plant progenies were selected from 21 F_4 generations and total of 101 advanced lines were selected and bulked from F_6 generation during T. Aman 2019.	Develop better genotypes for tidal ecosystem

Sl#	Research Progress	Expected output
	ii) **Introgression of dense and erect panicle gene in *indica* rice:** In objective to develop improved varieties, 06 new crosses are made and 139 F_1 seeds were collected during T. Aman 2019. A total of 418, 266 and 155 plant progenies were selected from 22 F_2 populations, 4 F_4 generations and 4 F_5 generations, respectively during T. Aman 2019 for further generation advance. A total of 2346 plant progenies from 22 crosses in F_3 generation and 403 plant progenies from 04 crosses in F_5 generation were selected with the objective to develop high yielding varieties having dense & erect panicles during Boro 2019-20. The total 149 advanced breeding lines were bulked from F_6 generation for further process as OYT.	Develop better genotypes with dense and erect panicle
	iii) Rice breeding for favorable condition: Out of 9 crosses, 5 crosses were confirmed and registered in BRRI Barishal station code BRBa73 to BRBa77. A total of 4903 F_1 seeds were obtained from 50 crosses during Boro 2019-20 which were targeted to develop high yielding Boro rice varieties. Besides, total of 222 plant progenies were selected from 05 F_2 population. In a special segregation population, during Aus 2019 about fifty thousand plants were grown from a bulked population seeds visually selected based on presence of awn. Out of that about 1500 plants were select based on presence of awn, plant type, grain, and panicle size. Selected plant population were grown in T. Aman 2019 and selected about 2400 better performing plants in respect of plant stature, panicle size and awn. The selected plant population was grown in Boro 2019-2020 and 1350 plant selection and 770 lines were bulked based on performance, uniformity and segregation present in each plant population.	Develop better genotypes for favorable condition
	iv) **Observational trial (OT):** A total of 101 entries along with four checks BRRI dhan28, BRRI dhan29, BRRI dhan58 and BRRI dhan74 were grown in BRRI Charbadna farm, Barishal during Boro 2019-20. Based on plant height, growth duration, phenotypic acceptability and grain yield performance, thirty one (31) genotypes were selected from 101 entries for further evaluation. Growth duration was ranged from 143-162 days where as grain yield was ranged from 5.02-8.34 t/ha.	Develop better genotypes
	v) **Preliminary Yield Trial (PYT):** The PYT consisting of six genotypes along with the two checks BRRI dhan27 and BRRI dhan48 were evaluated at South Ghatkhali and Tiakhali Block of Amtoli, Barguna in Aus 2019. Growth duration was ranged from 105-112 days where as grain yield was ranged from 3.32-4.51 t/ha. The three genotypes BR9829-78-1-3-2 (4.51 t/ha), BR9829-78-1-2-1 (4.49 t/ha) and BR9830-5-2-2-3 (4.47 t/ha) yielded better than both the checks having more or less similar growth duration. The three advanced lines BR9829-78-1-3-2, BR9829-78-1-2-1 and BR9830-5-2-2-3 were performed better in tidal non-saline ecosystem in terms of phenotypic acceptability, plant height, growth duration and grain yield and recommended for further generation advanced as RYT in Barishal region. Eleven advanced breeding lines along with BRRI dhan28, BRRI dhan58 and BRRI dhan74 as standard checks were evaluated at BRRI Charbadna farm, Barishal during Boro 2019-20. The highest grain yield was produce by check variety BRRI dhan74, and yield of test entries was ranged	Develop better genotypes

Sl#	Research Progress	Expected output
	from 5.41-6.78 t/ha.	
	vi) **Regional Yield Trial (RYT):** One RYT for non-saline tidal ecosystem consisting of three advanced breeding lines along with the two checks BRRI dhan27 and BRRI dhan48 was conducted at four locations of Barishal region during T. Aus 2019. The two advanced lines BR8784-4-1-2-P2 and BR8781-16-1-3-P2 were performed better in tidal non-saline ecosystem in terms of phenotypic acceptability, plant height, growth duration and grain yield and recommended f for further generation advanced as ALART in Barishal region. Two RYTs for ZER & DRR in T. Aman 2019 were conducted. RYTs for ZER consist of six entries along with the two checks BRRI dhan49 and BRRI dhan72 were grown at Charbadna farm, Barishal. The highest grain yield was found in the genotype BR9871-29-1-3-B (5.93 t/ha) followed by BR10001-94-2-B (5.77 t/ha) and BR9868-19-40-3-B (5.69 t/ha). The lowest grain yield (5.46 t/ha) was recorded in the genotype BRRI dhan49. RYTs for DRR consist of six entries along with the two checks BRRI dhan49 and BRRI dhan87 were grown at Charbadna farm, Barishal. The genotype BR10393-2-2-2 (RTV) (6.31 t/ha) produced the highest grain yield than the check varieties BRRI dhan49 (5.30 t/ha) and BRRI dhan87 (5.64 t/ha). The genotype BR10397-4-1-2 (BB) (5.93 t/ha) gave the similar grain yield but 06 days longer growth duration than the check BRRI dhan87 (5.64 t/ha). The genotypes BR10393-2-2-2-3 (RTV) (5.69 t/ha and 137 days) and BR10393-4-1-3-4 (RTV) (5.73 t/ha and 135 days) produced similar grain yield and growth duration with the check BRRI dhan49 (5.30 t/ha and 136 days). The lowest grain yield (5.30 t/ha) was recorded in the genotype BRRI dhan49. There was no disease symptom in this trial. A total of six RYTs in Boro 2019-20 were conducted. Two RYT of favorable Boro rice (FBR) were conducted. None of the genotypes performed better than the check varieties in RYT#FBR-1. The genotype BRH11-9-11-4-5B-HR3 provided the highest grain yield (8.37 t/ha) than the check BRRI dhan63 (6.45 t/ha) but gave similar grain yield with the check BRRI dhan58 (8.07 t/ha) in RYT#FBR-2. RYT of ZER consist of three entries along with the four checks were grown at Sagardi farm, Barishal. The genotype IR105837-8-45-1-1 provided highest grain yield (7.89 t/ha and 153 days) than all the check varieties (6.89-7.61 t/ha and 143-158 days) and 05 days earlier growth duration than the check variety BRRI dhan29 (153 days). RYT for PQR consist of four entries along with the three checks BRRI dhan50, BRRI dhan63, and BRRI dhan81 were grown at BRRI Sagardi farm, Barishal. The genotype BR8526-38-2-1-HR1 (7.70 t/ha and	Better genotypes wouldbe used for further advancement

Sl#	Research Progress	Expected output
	162 days) produced the highest grain yield but 10-17 days longer growth duration than all the check varieties (5.78-7.13 t/ha and 145-152 days). RYT#Bhanga consist of eleven entries along with the two checks were grown at Sagardi farm, Barishal. The genotype Bh Boro-18-SVIN063 (9.29 t/ha) provided the highest grain yield than the check varieties followed BRRI dhan50 (6.28 t/ha) and BRRI dhan89 (8.23 t/ha). RYT#Cumilla consist of five entries along with the three checks were grown at Sagardi farm, Barishal. The genotype BRC269-15-1-1-3 provided the highest grain yield (7.17 t/ha) followed by BRC297-15-1-1-1 (7.14 t/ha) that are similar with the check variety BRRI dhan58 (7.14 t/ha). The genotype BRC302-2-1-2-1 (7.06 t/ha and 146 days) gave the highest grain yield but 5 days longer growth duration than the checks BRRI dhan28 (6.33 t/ha and 141 days) and BRRI dhan81 (6.20 t/ha and 142 days).	
	vii) Advanced Yield Trial (AYT): One AYT consisting of thirty six advanced breeding lines was conducted during T. Aman, 2019.A total of thirty six entries along with the four checks were grown at BRRI Charbadna farm, Barishal during T. Aman 2019. Seventeen genotypes were selected on the basis of phenotypic acceptability, growth duration and grain yield for further generation advanced. Five AYTs were conducted during Boro 2019-20. Four, three, four, three and six advanced breeding lines were selected for further generation advance from AYT#1, AYT#2 AYT#3 AYT#4 and AYT#5 respectively.	Identify better genotypes
	viii) International Irrigated Rice Observational Nursery (IIRON): Seventy nine advance breeding lines along with five check varieties were evaluated at Charbadna farm, Barishal during Boro 2019-20. The genotype SVIN333 (7.67 t/ha) produced the highest grain yield than all the check varieties (6.39-7.11 t/ha). The three genotypes SVIN366 (7.49 t/ha and 141 days), SVIN028 (7.47 t/ha and 141 days) and SVIN312 (7.35 t/ha and 141 days) gave the similar yield but 6 days earlier growth duration with the check variety BRRI dhan29 (7.11 t/ha) and produced the higher grain yield than the checks BRRI dhan28, BRRI dhan58, BRRI dhan67 and BRRI dhan74. The eight genotypes namely SVIN375 (6.81 t/ha), SVIN323 (6.82 t/ha), SVIN313 (6.89 t/ha), SVIN318 (6.96 t/ha) SVIN311 (7.00 t/ha), SVIN304 (7.02 t/ha), SVIN316 (7.07 t/ha) and SVIN302 (7.10 t/ha) provided the similar grain yield with the checks BRRI dhan58 (6.80 t/ha) and BRRI dhan74 (6.85). The fourteen genotypes (6.39-6.77 t/ha) produced the similar grain yield than the checks BRRI dhan28 (6.39 t/ha) and BRRI dhan67 (6.46 t/ha).	Identify better genotypes
2	**Pest Management**	
	i) Impact of lighting period on the trapping of insect: For catching in light trap, six treatments were observed; T_1= 5.20 - 6.20pm, T_2= 6.20-7.20pm, T_3= 7.20-8.20pm, T_4 =8.20-9.20 pm, T_5=9.20- 10.20 pm,andT_6= 10.20 to rest of night and the treatments were replicate four times.T1 treatmentthat covers twilight(Godhuli) traps the highest number of insect pest and natural enemy (Table 7). Dusk to first four(04) hours caught 69.28% insect pests. First 3 hours (5.20pm to 8.20pm) insect caught decreasing and first 4 hours (5.20 to 9.20 pm) natural enemy caught also decreasing trend.Total insect pest and natural enemies caught in light trap	Find out effective light trapping time period for farmers

Sl#	Research Progress	Expected output
	was 16825 and 1942 that was in percentage of total population, 89.65% and 10.35% respectively.	
	ii) Rat caught preference to different lure: To find out effective lure for rat trapping, an experiment was designed with four Treatments-T_1=Coconut, T_2=Dried fish, T_3=Paddy, T_4= Without feed/lure and the treatments were replicated thrice.Experiment was conducted with 20 Bamboo trap at Charbadhna farm, BRRI Barishalduring T. Aman 2019. Higher no. rat caught found with coconutlure than followed by dried fish and paddy. Coconut lure found higher preferable to rat than dried fish and paddy.	Effective lure against rat would be identified
	iii) Survey of rice insect pest in seedbed using Yellow sticky trap:BR26, BRRI dhan67 seedbed of sagordi farm and BRRI dhan67, BRRI dhan88, BRRI dhan89, BRRI dhan28, BRRI dhan29, BRRI dhan58 of Charbadna farm. Brown planthopper(BPH), white backed planthopper(WBPH), yellow stemborer(YSB), leaf folder(LF), green leafhopper(GLH), whiteleafhopper (WLH), zigzag leafhopper (ZLH) insect found in yellow sticky trap.Carabid beetle (CDB), lady bird beetle(LBB), green mirid bug(GMB) and spider (SPD) natural enemy were found. Higher insect and natural enemy found in Charbadna than Sagordifarm, Bangladesh Rice Research Institute, Barishal.Brown planthopper, green leafhopper, leaf folder, yellow stemborer were found higher population. Other hand, natural enemiesgreen miridbug, lady bird beetle, carabid beetle found higher population.	Seedbed insect pest would be identified.
	iv) Conservation of natural enemies through ecological engineering approaches: To conserve natural enemies through ecological engineering approaches, Nectar-rich flowering plants and or weeds planted on bunds to provide food and shelter for different natural enemies, e.g. parasitoids. Twenty (20) complete sweeps will be taken at every 07 days interval up to flowering. T_1 = Flowering plants (marigold, sunflower) grown in rice bunds, T_2 = Control**.** Higher number of insect pest abundance found in control plot than ecological management plot.On the other hand, higher no. of natural enemy incidence of ecological engineering plot than control plot.Similar yield found in both ecological engineering plot(6.71t/ha) and control plot(6.70t/ha).	Conservation of natural enemy would be identified
	v) Insecticide free rice production in BRRI, Barishal farm: To reduces insecticides uses in Sagordi and Charbodna farm of BRRI, Barishal. Install 100 perch at one hectare of land to facilitate birds to sit on and took randomized 20 complete sweep for counting insect pests and natural enemy and identifying plots that occur potential infestation by certain insect pest. And it was practiced in the morning at every seven days interval before flowering. Once the infested plots was identified, complete sweeping operation was conducted in that plot and after every 40-50 sweeping harmful insects were damaged mechanically and beneficial insects were released to field. Boro 2019-20 foundhigher no. of insect in BRRI dhan67 followed by BRRI dhan89 and BRRI dhan88. Green leafhopper(GLH), white leafhopper(WLH),yellow stemborer(YSB) and brown planthopper(BPH) found all three variety plot. Other hand, higher no. of natural enemy in BRRI dhan89 than BRRI dhan88 and BRRI	Reduce insecticides uses 50-100% in farmers field

Sl#	Research Progress	Expected output
	dhan67.Higher yield performance in BRRI dhan89 than BRRI dhan88 and BRRI dhan67. Finally, we successfully cultivated Breeder, TLS and Experiment plot crop without any insecticides spray at BRRI Charbadna and Sagordi farm. Perching was done all plot at BRRI recommendation practice. Every full plot sweeping after 15 days of transplanting upto flowering. After every 20 complete sweeping release natural enemy and where damaged harmful insect. Morning time yellow stem borer harbor upper portion of leaf. So, we done sweeping early morning 6.00am to 10.00am.	
	vi) Conservation of natural enemies through ecological engineering approaches: To conserve natural enemies through ecological engineering approaches, Nectar-rich flowering plants and or weeds planted on bunds to provide food and shelter for different natural enemies, e.g. parasitoids. Twenty (20) complete sweeps will be taken at every 07 days interval up to flowering. T_1 = Flowering plants (marigold, sunflower) grown in rice bunds, T_2 = Control**.** Higher number of insect pest abundance found in control plot than ecological management plot.On the other hand, higher no. of natural enemy incidence of ecological engineering plot than control plot.Similar yield found in both ecological engineering plot(6.71t/ha) and control plot(6.70t/ha).	Conservation of natural enemy would be identified
	V1) Screening of available pesticides for controlling blast disease of rice: Nine pesticides (Table 39a) viz**.** Zeal, Difa, Kasumin, Amister Top, Karishma, Blastin, Sindazim, Sandomil and Nativo were used as test pesticides keeping one negative control (plain water). Pesticides were tested on BRRI dhan28, a susceptible Boro HYV of rice to blast disease. Among the nine chemicals Nativo (91.10%), Difa (76.52%), Blastin(72.27%) and Zeal (71.38%) significantly reduced neck blast (NB) disease. Rest of the chemicals were not effective (<60 % reduction) in reducing the blast disease. Further test of those effective chemicals was suggested for the next season.	Effective pesticides against blast disease would be identified
	V11. Survey and monitoring of rice diseases in selected areas: In Aman and Boro seasons, survey on rice disease was conducted in 46 farmers' fields of Barishal district (Sadar, Ujirpur, Babuganj). Cropping pattern, rice growing ecosystem and cultivar adoption of the surveyed area were observed during survey. Data on percent disease incidence (%DI) and severity (0-9 scale) were collected following the Standard Evaluation System (SES) for rice (IRRI, 2013). A zigzag pattern for survey was followed in this study (Savary*et al*., 1996). From each plot, randomly 20 hills were selected for recording the disease incidence and severity. Brown spot and Bacterial Leaf Blight was recorded as major diseases.	The status of different rice diseases in southern region would be investigated.
	V111. Demonstration on the management options of blast disease at farmers' field of Barishal region: To demonstrate the efficacy of fungicides against blast disease and to introduce management practices to the farmers the experiment was conducted during Aman 2019 farmers' field of Babuganj, Barishal under natural field condition using blast susceptible rice variety BRRI dhan34. BRRI recommended practices (RP) were tested	Management practices and efficacy of fungicides against blast disease to the

Sl#	Research Progress	Expected output
	over farmers' practices (FP). BRRI recommended practices were - application of half dose of MOP at basal and half at the last top dress of urea (PI stage); providing supplement irrigation immediately after disease initiation and judicial application of fungicides (Trooper/Zeal/Nativo two times at 10-15 days interval). Farmers didn't use MOP and/or chemical under Farmers' practice option. For neck blast, fungicides were sprayed two times; first at heading stage (around 5% flowering) and 2nd at 10 days after the 1st spray. Chemical trooper was sprayed at afternoon. Disease severity and yield data were collected during ripening stages. Yield of BRRI dhan34 was significantly higher in recommended practices (4.30 tha^{-1}) over farmers' practices (3.57 tha^{-1}). Disease incidence was 11.9% in RP treatment while it was 63% in control treatment. The yield increase was observed in recommended practice by 20.44% and disease incidence decreased by 81.1% over farmers' practice.	farmers would be introduced.
3	**Socio-Economics and Policy**	
	Stability analysis of BRRI released HYVs of rice: This study was conducted for finding out the suitable rice cultivars in Barisal region. Forty two (42) BRRI released varieties were tested with three groups namely Short Duration Variety (14nos), Medium Duration Variety (11nos) and Long Duration Variety (17nos) during Aman 2019 season. Forty three varieties with two groups namely Short Duration Variety (20) and Long Duration Variety (23). were evaluated during Boro 2019-20 seasons. Both the study were accomplished at Charbadna farm, BRRI regional station, Barishal. The Aman 2019 experiment was affected by cyclone Bulbul on 10 November, 2019. Among the tested 14 nos of short duration variety, the highest yield was observed in BRRI dhan87(6.12 tha^{-1}) followed by BRRI dhan73 (5.38 tha^{-1}). In medium duration varieties, the highest yield was found in BRRI dhan70 (6.18 t/ha) followed by BRRI dhan49 (5.39 t/ha). Finally, among the long duration varieties, the highest yield was foundin BRRI dhan77 (5.55 t/ha) followed by BR 23 (5.49 t/ha) and BRRI dhan76 (5.39t/ha). Among the tested short duration varieties, the highest yield was observed in BRRI Hybrid dhan3 (8.20 tha^{-1}) followed by BR1(6.62 tha^{-1}) and BRRI dhan68 (6.35 tha^{-1}). In the long duration varieties, the highest yield was in BRRI dhan89 (8.20 t/ha) followed by BRRI dhan58 (7.56 t/ha) and BRRI dhan92 (7.00 t/ha).	Region basis suitable rice varieties would be identified
4	**Technology transfer**	
	i) Varietal replacement through Head to Head Trial: Two groups of BRRI released modern rice varieties were tested at 10 locations of Barishal region, Barishal during T. Aman 2019. BRRI dhan52 group, comprising of BRRI dhan 52, BRRI dhan72, BRRI dhan73, BRRI dhan76 and BRRI dhan79, were tested in five locations. Among these group, BRRI dhan72 (5.45 t/ha) provided the highest yield followed by BRRI dhan52 (5.29 t/ha), BRRI dhan76 (5.12 t/ha), BRRI dhan79 (4.84 t/ha) and BRRI dhan73 (4.58 t/ha). BRRI dhan49 group, comprising of BRRI dhan49, BRRI dhan71, BRRI dhan75, BRRI dhan80 and BRRI dhan87, were tested in	maximizing rice yield by adopting BRRI release latest varieties

Sl#	Research Progress	Expected output
	other five locations. Among these group, BRRI dhan87 (5.46 t/ha) provided the highest yield followed by BRRI dhan49 (5.3 t/ha), BRRI dhan80 (5.08 t/ha), BRRI dhan71 (4.83 t/ha) and BRRI dhan75 (4.68 t/ha). Based on the performance, the varieties BRRI dhan49, BRRI dhan52, BRRI dhan72 BRRI dhan76 and BRRI dhan87 could be disseminated among the farmers in Barishal region. Two groups of BRRI released modern rice varieties were tested at 6 locations of Barishal region, Barishal during Boro 2019-20. BRRI dhan28 group, comprising of BRRI dhan28, BRRI dhan67, BRRI dhan81, BRRI dhan84 and BRRI dhan88, were tested in four locations. Among these group, BRRI dhan67 (6.41 t/ha) provided the highest yield followed by BRRI dhan88 (6.16 t/ha), BRRI dhan28 (5.98 t/ha), BRRI dhan81 (5.92 t/ha) and BRRI dhan84 (5.76 t/ha). BRRI dhan29 group, comprising of BRRI dhan29, BRRI dhan58, BRRI dhan89 and BRRI dhan92 were tested in other two locations. Among these group, BRRI dhan29 (6.55 t/ha) provided the highest yield followed by BRRI dhan89 (6.43 t/ha), BRRI dhan92 (6.43 t/ha) and BRRI dhan58 (6.40 t/ha). Based on the performance, the varieties BRRI dhan29, BRRI dhan67, BRRI dhan88 and BRRI dhan92 could be disseminated amongthe farmers in Barishal region.	
	Demonstration, seed production and scaling up of MV rice in Barisal region: During the reporting year,BRRI Barishal has conducted, 3 demonstrations in Aman season and 4 demonstrations in Boro season which was 14 acre by area coverage. During Aman 2019, highest yield was obtained by BRRI dhan23 (5.1t/ha) followed by BRRI dhan52 (5.07 t/ha) and BRRI dhan76 (4.9 t/ha). The growth duration varied from 143-156days. Farmers retained thes eed of those varieties especially BRRI dhan76 and BRRI dhan77 for selling or sharing with surrounding farmers and to cultivate in the next season.During boro 2019-2020, five vatieries viz., BRRI dhan47, BRRI dhan58, BRRI dhan67, BRRI dhan74 and BRRI dhan89 were demonstrated and the highest yield was found in BRRI dhan89 (7.53t/ha) followed by BRRI dhan74 (7.17 t/ha), BRRI dhan58 (6.82 t/ha), BRRI dhan67 (6.34 t/ha), BRRI dhan47 (5.99 t/ha). Farmers were motivated to cultivate BRRI dhan89, BRRI dhan74 and BRRI dhan58. And retained the seeds of those varieties.	Farmers would be motivated to cultivate HYVs of rice
	Seed support demonstration: Fifty three seed support demonstration were conducted. Twenty five block demonstrations of ten bigha each with BRRI dhan76 and BRRI dhan77 during T. Aman2019 in different upazilas of Bhola were conducted with active collaboration of DAE. Similarly twenty eight seed support demonstration were conducted in Babugonj Barishal during Boro, 2019-2020.	Farmers would be motivated to cultivate HYVs of rice
	ii) Varietal replacement through Head to Head Trial: Two groups of BRRI released modern rice varieties were tested at 10 locations of Barishal region, Barishal during T. Aman 2019. BRRI dhan52 group, comprising of BRRI dhan 52, BRRI dhan72, BRRI dhan73, BRRI dhan76 and BRRI dhan79, were tested in five locations. Among these group, BRRI dhan72 (5.45 t/ha) provided the highest yield followed by BRRI dhan52 (5.29 t/ha), BRRI dhan76 (5.12 t/ha), BRRI dhan79 (4.84 t/ha) and BRRI	maximizing rice yield by adopting BRRI release latest varieties

Sl#	Research Progress	Expected output
	dhan73 (4.58 t/ha). BRRI dhan49 group, comprising of BRRI dhan49, BRRI dhan71, BRRI dhan75, BRRI dhan80 and BRRI dhan87, were tested in other five locations. Among these group, BRRI dhan87 (5.46 t/ha) provided the highest yield followed by BRRI dhan49 (5.3 t/ha), BRRI dhan80 (5.08 t/ha), BRRI dhan71 (4.83 t/ha) and BRRI dhan75 (4.68 t/ha). Based on the performance, the varieties BRRI dhan49, BRRI dhan52, BRRI dhan72 BRRI dhan76 and BRRI dhan87 could be disseminated among the farmers in Barishal region. Two groups of BRRI released modern rice varieties were tested at 6 locations of Barishal region, Barishal during Boro 2019-20. BRRI dhan28 group, comprising of BRRI dhan28, BRRI dhan67, BRRI dhan81, BRRI dhan84 and BRRI dhan88, were tested in four locations. Among these group, BRRI dhan67 (6.41 t/ha) provided the highest yield followed by BRRI dhan88 (6.16 t/ha), BRRI dhan28 (5.98 t/ha), BRRI dhan81 (5.92 t/ha) and BRRI dhan84 (5.76 t/ha). BRRI dhan29 group, comprising of BRRI dhan29, BRRI dhan58, BRRI dhan89 and BRRI dhan92 were tested in other two locations. Among these group, BRRI dhan29 (6.55 t/ha) provided the highest yield followed by BRRI dhan89 (6.43 t/ha), BRRI dhan92 (6.43 t/ha) and BRRI dhan58 (6.40 t/ha). Based on the performance, the varieties BRRI dhan29, BRRI dhan67, BRRI dhan88 and BRRI dhan92 could be disseminated amongthe farmers in Barishal region.	
5	**Seed production**	
	i)Breeder seed production: In T. Aman 2019, a total of 16,000 kg and in Boro 2019-20, a total of 31,040 kg breeder seed were produced.	BRRI released HYVs of rice would be disseminated
	ii) TLS production: In T. Aman 2019, a total of 9733 kg TLS and in Boro 2019-20 a total of 24,728 kg BRRI released varieties were produced.	

BRRI Regional Station, Bhanga, Faridpur

Table - 2

Research Progress 2019-2020

Sl.No.	Experimental title	Expected Output/ Outputs
	Varietal development	

1	Hybridization	In Aman 2019 season, 10 crosses were made and 1986 F_1seeds were produced for developing high yielding transplanting Aman rice varieties with desirable characters with emphasis on water stagnation tolerance, anaerobic tillering, earliness, and acceptable grain quality. For the development of deepwater rice variety, 23 crosses were made and 2706 F_1seeds were produced with desirable characters with emphasis on kneeing ability, nodal tillering, elongation ability and awnless grain with acceptable quality.
2	Field Rapid generation advance (FRGA)	In case of 'breeding for developing high yielding rice varieties for single boro ecosystem' 10395 plants of F_4 generation were grown during Boro 2019-20 using Field RGA and 2930 progenies of F_5 generation were maintained by collecting single panicle from each plant as modified single seed descent (SSD) method.
3	Proposed variety trial (PVT) (Boro)	Three sets (Set-1, Set-2 and Set-3) of inbred trial (Boro 2019-20) were evaluated following randomized complete block design with three replications at BRRI Bhanga, Faridpur. Set-1: In a proposed variety trial, one advanced breeding line I-012 along with two checks (I-010 and I-011) was tested. Line no. I-012 produced 8.63 t/ha which was 16.62% and 31.35% higher yield than the both check varieties coded I-010 and I-011 respectively.The growth duration of line no. I-012 was around five days longer than I-011 or similar to the I-010 line, respectively. Set-2: One advanced breeding line I-014 was evaluated along with a check. Line no. I-014 gave 8.75 t/ha yield which was 5.42% higher than the check (I-013) with three days shorter growth duration. Set-3: In this trial, one advanced breeding line (I-017) along with two checks (I-015 and I-016) were tested. Line no. I-017 produced 8.71 t/ha yield
Sl.No.	**Experimental title**	**Expected Output/ Outputs**
		which was more than 1.0 t/ha higher (12.67% and 14.15%) than the both checks. The growth duration of the lines ranged from 147-155 days and growth duration of the line no. I-017 was 152 days.

4	ALART (PQR) Boro	Two advanced lines BR8862-29-1-5-1-3 and BR8995-2-5-5-2-1 along with BRRI dhan50 (check) were tested at farmers' field at Nagarkanda, Faridpur. Two tested lines out yielded (6.91-7.47 t/ha) than that of the average yield of check variety BRRI dhan50 (6.79 t/ha). The mean growth duration of BR8862-29-1-5-1-3 was 162 days which was similar to the check variety BRRI dhan50 (162 days).
5	ALART (ZER) Boro	One advanced line IR99285-1-1-1-P2 along with BRRI dhan29 and BRRI dhan84 as checks were evaluated at farmer's field at Nagarkanda, Faridpur. The advanced line IR99285-1-1-1-P2 produced 9.12 t/ha yield which was little higher (012 t/ha) than BRRI dhan29 and 4.0 t/ha higher than BRRI dhan84. The mean growth duration of advanced line IR99285-1-1-1-P2 was similar to the check variety BRRI dhan29 and 18 days longer duration than the other check BRRI dhan84
6	RYT (DWR, FBR, ZER, IRR, FBC, PQR)	RYT-DWR: Boroi digha and Fulkori yielded 2.06 t/ha and 1.47 t/ha significantly higher than check BR10230-15-27-7B with similar growth duration in Majhikanda and Talma. RYT- FBR-Bhanga: Among the tested genotypes, Bh Boro-18-SVIN076 gave the highest mean yield (7.90 t/ha) ranged from 4.42 to 10.62 t/ha followed by BhBoro-18-SVIN063 (7.67 t/ha), Bh Boro-18-SVIN077 (7.13 t/ha), Bh Boro-18-SVIN109 (7.12 t/ha) and Bh Boro-18-SVIN066 (6.90 t/ha) (Table 5). On the other hand, nine advance lines gave higher yield (6.18-7.90 t/ ha) than the standard check BRRI dhan50 (6.15 t/ha) with a few days longer growth duration except Bh Boro-18-SVIN069. Bh Boro-18-SVIN076 and BhBoro-18-SVIN063 may be selected for conducting ALART that are suitable for single boro ecosystem.
Sl.No.	**Experimental title**	**Expected Output/ Outputs**
7	Morphological Characterization of Pigmented Boro Rice Germplasm	An experiment was conducted to characterize 100 pigmented rice germplasm through 51 agro-morphological traits (20 quantitative and 31 qualitative characters) using the Rice Germplasm

		Descriptors and Evaluation Form, GRSD, BRRI. The experiments were conducted in BRRI R/S Bhanga, Faridpur. The present study exhibits high variability in most of the observed traits of pigmented Boro rice germplasm.
8	Farming Systems Research Identification of potential rice variety in Onion-Jute-Relay Aman cropping Pattern under shallow deep water rice ecosystem.	For identification of potential rice variety in Wheat/Onion-Jute-Relay Aman cropping Pattern under shallow deep-water rice ecosystem, highest yield of rice (3.9 tha^{-1}) was obtained from BRRI dhan39 that was relayed with jute. Highest REY (Rice equivalent yield) was found from T_5 (24.74 tha^{-1}) cropping pattern followed by T_2 (24.17 tha^{-1}) and T_4 (22.74 tha^{-1})
9	Crop-soil-water management Nitrogen and K management of newly released short duration modern T. Aman rice varieties	In the experiment on effect of nitrogen and potassium management on growth and yield of short duration T. Aman rice, yield of BRRI dhan71 was significantly higher in T_4 (4.2 t/ha) followed by T_2 (3.73 t/ha). There was no significant difference in yield among treatments when BRRI dhan75 was used. In context of plant height and sterility, there was no significant difference in two varieties among four treatments.
10	Stability of yield of BRRI released Aman varieties	The most stable rice variety identified. In long duration Aman varieties, BR22, BRRI dhan41 and BRRI dhan46 gave the highest grain yield (4.1 t/ha) followed by BRRI dhan44 (3.9 t/ha) and BR23 (3.6 t/ha). Among short duration Aman varieties, BRRI hybrid dhan4 produced the highest yield (4.2 t/ha) followed by BRRI dhan71 (3.7 t/ha) and BRRI dhan56 (3.6 t/ha). BRRI hybrid dhan6 gave the highest grain yield (4.4 t/ha) among medium duration Aman varieties followed by BRRI dhan70 (4.3 t/ha) and BRRI dhan73 (4.1 t/ha), BRRI dhan53 (4.1 t/ha), BRRI dhan49 (4.1 t/ha). In Boro season, among the long duration varieties, yield of BR16 was the highest (7.4 t/ha) followed by BRRI dhan92 (7.32 t/ha) and BRRI dhan29 (7.10 t/ha). In short duration, Boro varieties BRRI Hybrid dhan2
Sl.No.	**Experimental title**	**Expected Output/ Outputs**
		produced the highest (7.8 t/ha) yield followed by BRRI Hybrid dhan5 (7.69 t/ha) and BRRI Hybrid dhan3 (7.16 t/ha).
11	Technology dissemination and training	Newly released varieties disseminated. Training on

		Rice Production Technology was imparted among 300 famers and SAAO of the Faridpur Region.

Regional Station, Cumilla

Table-2

Research Progress 2019-2020

Sl. No.	Research Progress	Expected Output
Program area (01): Varietal Development Program (VDP)		
1	Project 01: Development of new varieties and improved genotypes with high yield potential along with earliness, photoperiod sensitivity, acceptable grain quality and resistance to diseases and insect pests.	
T. Aman 2019 and Boro 2019-20		
1.1	Hybridization: In T. Aman season, 28 crosses were made using 71 parents. In Boro season 17 crosses were made using 35 parents.	High yielding new breeding lines will be developed.
1.2	F_1 Confirmation : Thirty nine (T. Aman) and 4 (Boro) crosses were confirmed and registered in BRRI Cumilla.	High yielding new breeding lines will be done
1.3	Growing of F_2 population: About 235 progenies from 19 crosses (T. Aman) and 526 progenies from 15 crosses (Boro) were selected.	High yielding new breeding lines will be done
1.4	Pedigree Nursery (F_3, F_4, F_5 and F_6 generations): In T. Aman season, 77, 45 and 31 plants were selected from F_3, F_4 and F_5 generation, respectively and 8 breeding lines were bulked from F_5 to F_6 generation. In Boro season, 830 progenies were selected from F_3-F_5 and 38 lines were bulked from F_6-F_7. In field RGA method total 4,601 progenies were harvested and selected for LST for next Boro season.	High yielding new breeding lines will be done
1.5	Observational Yield trial (OYT): BRC436-17-3-1-1 (5.49 t/ha, 124 days), BRC437-44-1-4-1 (5.00 t/ha, 128 days) and BRC417-16-2-2-1 (5.32 t/ha, 134 days) were selected in T. Aman season based on their yield and shorter growth duration compared to the check varieties. In Boro season, 23 genotypes were selected out of 37 genotypes based on yield and other parameters. Total 41 entries from 435 performed better and gave yield more than 8 t/ha in OYT CTR (TRB). Total 17 entries from 128 performed better and gave yield more than 7.5 t/ha and these entries may be selected for further evaluation.	High yielding with short duration new breeding lines will be developed
1.6	Preliminary Yield Trial (PYT): In T. Aman season, 9 entries were selected from PYT (Com) for higher yield (5.0-6.61 t/ha) and shorter growth duration (114-126 days) than check BRRI dhan49 (4.91 t/ha and 125 days) and statistically similar yield with BRRI dhan75 (6.10 t/ha and 124 days) and BRRI dhan 87 (6.26 t/ha and 125 days) In PYT (ING-1) 6 entries performed better considering yield (4.97-5.46 t/ha) and growth duration (113-126 days) compared to check varieties.	High yielding with short duration, BB resistant, GSR new breeding lines will be developed

Sl. No.	Research Progress	Expected Output
	In PYT (ING-2) 2 entries namely IR104511:1-B-21-4-22-11-3-B (5.35 t/ha and 111 days) and IR104548:8-B-15-10-3-11-3-B (5.39 t/ha and 114 days) were selected. In PYT (GSR) nine (9) entries performed better compared to check varieties on the basis of yield and growth duration. During Boro season, 16 genotypes were selected out of 22 genotypes based on yield and other parameters. The heritability obtained from yield was 71%, indicating high level of precision of this experiment. Considering the yield and growth duration BR9943-4-2-3-1 (9.06 t/ha and 162 days) and BR9943-26-2-3-6 (8.74 t/ha and 161 days) these two genotypes were selected from PYT BB (TRB)	
1.7	AGGRi Network Trial : During T. Aman season, 72 lines performed better than the standard checks BRRI dhan87 on the basis of yield and their yield range was 4.41-5.62 t/ha from 387 advanced breeding lines developed at IRRI-HQ, Manila, Philippines.	High yielding new breeding lines will be done
1.8	Secondary Yield Trial (SYT): In SYT (Com), BRC355-9-1-1-1, TP30500, TP30523, TP30526 and TP30546 were selected for higher yield (5.36-6.17 t/ha) and shorter duration (114-120) than the checks during T. Aman. In SYT#1, 9 out of 12 genotypes and in SYT#2, 4 genotypes were selected based on yield and other parameters during Boro season.	High yielding with short duration new breeding lines will be done
1.9	Advanced Yield Trial (AYT): In T. Aman, 3 genotypes viz. BR9043-11-3-2-2 (4.95 t/ha and 122 days), BRC315-14-2-3-1-1-H1 (4.99 t/ha and 120 days) and IR70213-10-CPA-4-2-2-2 (5.46 t/ha and 123 days) were selected from AYT#1 (COM) due to higher yield and shorter growth duration compared to checks and BR7849-35-2-2-1-1-P2 from AYT#2 (W/S) was selected for its better yield (5.23 t/ha). In Boro season, 1 genotype was selected out of 3 based on yield and other parameters and 27 genotypes performed well and gave yield higher than 7 t/ha in AYT# FBR (TRB).	High yielding with short duration new breeding lines will be developed
1.10	Regional Yield Trial (RYT-HQ & R/S) During T. Aman season, 4 entries were selected from RYT (Insect resistant), for higher yield (5.73-6.19 t/ha) and shorter growth duration. BR10397-4-1-2 and BR10395-22-3-5 (Blast) were selected from RYT (BB) for higher yield. From RYT#1 (RLR) BR9571-28-2-1-2-1, BR9571-4-1-2-2-1 and BR9571-4-2-6-1-1 were selected for their higher yield (5.10-5.38 t/ha) and BR9571-13-1-9-1-1 was selected from RYT#2 (RLR) compared with standard checks. From RYT (ZER), BR10001-94-2-B from RYT ZER (RLR) BR8492-9-5-3-2 (RLR) and BR7528-2R-HR16-2-24-1 were selected for their better yield performance compared to standard checks. No genotypes were found promising in respect of yield performance, BPH, growth duration, lodging tolerant, rat damage and other agronomic characters from RYT Kataribhog (PQR), RYT (DTR), RYT #1 (DWR), RYT#2 (DWR) and RYT (Bio). During Boro season, 3 entries in RYT (PQR), 1 entry of RYT	High yielding with short duration, insect, disease, RLR, ZER and/or PQR new varieties will be developed

Sl. No.	Research Progress	Expected Output
	(ZER) and 1 entry of RYT#2 performed better than standard check varieties. None of the entries performed better than check variety in RYT (Bhanga) and RYT (FBR).	
1.11	Regional Yield Trial (RYT)-CUM, Boro In 4 locations of Cumilla region, BRC302-2-1-2-1 (7.43 t/ha) gave highest yield than standard check BRRI dhan58 (7.21 t/ha).	High yielding new varieties will be developed
Program area (02):Crop-Soil-Water Management		
T. Aman 2019 and Boro 2019-20		
2.1	Influence of nitrogen and potassium rates on performance of modern rice During T. Aman 2019 season, $N_{100}K_{100}$ was the best for grain yield (6.31 t/ha) & straw yield (6.69 t/ha) of BRRI dhan87 out of four fertilizer treatments N_0K_0, $N_{100}K_{100}$, $N_{100}K_0$ and N_0K_{100}. In Boro season, $N_{140}K_{150}$ was the best combination for grain yield (7.39 t/ha) & straw yield (8.47 t/ha) on BRRI dhan89.	NK interaction effect on rice yield can be determined.
2.2	Long-term missing element trail for diagnosing the limiting nutrient in soil in BRRI R/S Cumilla In rainfed ecosystem, BRRI dhan49, BRRI dhan79 and BRRI dhan87 produced 5.93 t/ha, 6.46 t/ha and 6.61 t/ha grain yield, respectively with STB fertilizers and required much higher P, K, S and Zn in the time of applied nutrients. In irrigated ecosystem, BRRI dhan84, BRRI dhan86 and BRRI dhan88 produced 6.50, 6.63 and 7.38 t/ha grain yield, respectively with STB fertilizers. Omission of N seemed to be the most yield limiting factor for rice during both T. Aman and Boro seasons.	Limiting nutrient factor on rice yield in rainfed and irrigated ecosystem will be determined.
2.3	Evaluation of bio-organic fertilizer in soil-plant system Application of 2 ton/ha bio fertilizer with N (70%) + KS (100%) appeared as best for grain yield (5.22) and straw yield (5.94) of BRRI dhan75. Application of the same treatment gave the highest grain (8.05 t/ha) and straw yield (8.40 t/ha) in BRRI dhan89.	Impact of Bio-organic fertilizer on rice yield will be determined.
2.4	Efficiency of DAP fertilizer for the supplementation of nitrogen fertilizer during Boro season Treatment, DAP + N100% (3 times), produced the highest grain yield (5.77 t/ha) and straw yield (6.21 t/ha) of BRRI dhan81.	Economic and efficient Urea and DAP fertilizer dose will be determined .
Program area (03): Pest management		
3.1	Survey and yield loss assessment of rice blast disease in Cumilla district Disease incidence of bacterial blight, sheath blight, neck blast, false smut and brown spot were 5-30, 5-90, 1-80, 0.01-5 and 20-100 % respectively during T. Aman 2019 season. During Boro 2019-20 season, major rice diseases bacterial blight, sheath blight and neck blast were recorded ranged from 1-50, 1-60 and 1-40 % in BRRI released and local varieties respectively.	Disease forecast model will be developed.

Sl. No.	Research Progress	Expected Output
3.2	Validation of rice neck blast disease management technology under farmer's field condition Neck blast disease was obtained severe 66% disease incidence (DI) in BRRI dhan34 at farmers practice compared to BRRI practice (upto 5% DI) at BRRI farm, Cumilla during T. Aman 2019 season and rice yield loss was saved upto 42 % by managing neck blast disease.	Yield loss due to blast disease will be reduced.
3.3	Factors affecting rice tungro disease and its management in Cumilla region Several field experiments were conducted in different locations of Nangalkot and LaksamUpazila, Cumilla during Aus, T. Aman and Boro 2019-20 seasons. Preventive measure is the only way to control tungro disease. GLH population was very low in insecticide sprayed seed bed and main plot compared to control plots.The weather parameters greatly influenced the population of GLH in rice field. It was found that increased yearly temperature with low rainfall, susceptible rice variety, 3 rice cropping pattern and huge number of GLH in the seedbed are the most critical factors for tungro disease devastation. Recommended rice tungro disease management technology is given below: 1. Seedbed along with surroundings should be free from GLH by light trapping/hand sweeping/insecticide spray. 2. Spray systemic insecticide (MIPC 2.6g /Cartap 2.4g /Carbaryl 3.4g / Chorpyriphos 2ml / Carbosulfan 2ml per litre water are the most effective is the most effective) in the seedbed for 2 times for controlling GLH. The season-wise spray times are as follows: a) During Aus season, 10 days after seeding (DAS) and 20 DAS (about 3-5 days before transplanting) b) During T. Aman season, 10-15 DAS and about 5 days before transplanting c) During Boro season, 15-20 DAS and about 5 days before transplanting	Tungro disease management technology will be developed.
3.4	Tracking the infection source(s) of rice false smut disease False smut disease was not present in each treatment of 3 seedling times for tested varieties BRRI dhan49 and BRRI dhan79.Therefore, the experiment is needed to repeat in the next T. Aman 2020 season.	Mode of infection of false smut disease will be determined.
3.5	ALART for Bacterial Blight disease of rice The BB resistant genotypes BR8938-19-4-3-1-1-P2-HR3, BR9651-15-2-1-4 &BR(Bio)11447-1-28-14-3 and check BRRI dhan58 didn't show BB disease. One genotype BR(Bio)11447-3-10-7-1 showed very low BB disease (% DI 10 & DS 3) along with check BRRI dhan28 (% DI 20 & DS 3), which indicated that BB disease pressure is naturally very low in the reporting season. However, all the 4 genotypes showed remarkably susceptible to neck blast disease (% DI 23-73 & DS 7-9). For this reasons, none of the genotypes are recommended from BRRI Cumilla for further progress in varietal development program.	Bacterial blight disease resistant variety will be developed.

Sl. No.	Research Progress	Expected Output
3.6	ALART for Blast disease of rice The genotype HR(Path)-11 showed fully resistant (%DI & DS 0) to both leaf (LB) and neck blast (NB) compared to susceptible checks BRRI dhan58 (NB %DI 48, DS 7) and BRRI dhan29 (NB %DI 85, DS 9). Rest 2 genotypes (Path2441 &BR(Path)12452-BC3-16-19) showed highly susceptible to neck blast as susceptible checks.During grain filling stage, HR(Path)-11 showed 100 % lodging. For those reasons, none of the genotypes are recommended for further progress, but HR(Path)-11 can be used as blast resistant donar parent.	Blast disease resistant variety will be developed.
3.7	Screening of Blast, BB and Tungro resistant monogenic lines in disease hot spot of Bangladesh Both T. Aman and Boro seasons, Blast resistant lines # 16, 42, 44, 45, 46, 95 and check BRRI dhan74 showed both leaf and neck blast resistant in the natural field condition. In both seasons, BB resistant lines # 47-73, all lines including checks didn't show BB disease except 2 lines # 47 and 48 (DS 5-7) in Aman season. Among the tungro resistant lines # 74-91, entry # 74-76, 81-83, 87-91 showed resistant reaction to rice tungro disease whereas, check varieties showed susceptible to tungro during Aman but these lines didn't show Tungro disease in Boro season.	Blast, Bacterial blight and tungro disease resistant lines will be developed.
3.8	Screening of blast resistant LST lines in blast hot spot area in Cumilla, Boro 2019-20. Neck & Leaf blast free 36 genotypes out of 3988 were selected in natural field condition. Rest of the genotypes was infected with Neck blast (DS 5-9).	Blast disease resistant lines will be developed.
Program Area (04) : Socio-Economics and Policy		
4.1	Stability Analysis of BRRI developed rice varieties: During T. Aus 2019, BRRI dhan48 (4.42 t/ha) gave the highest yield followed by BRRI dhan43 (3.72 t/ha) BRRI dhan65 (3.60 t/ha), BRRI dhan85 (3.60 t/ha), BRRI dhan82 (3.56 t/ha) and BRRI dhan42 (3.50 t/ha). In T. Aman 2019, BRRI Hybrid dhan4 gave highest yield (6.08 t/ha) followed by BRRI dhan87 (5.47 t/ha), BRRI dhan52 (5.2 t/ha), BRRI dhan51 (5.18 t/ha), BRRI dhan57 (5.16 t/ha) and BR23 (5.10 t/ha). During Boro 2019-20, BRRI Hybrid dhan3 gave the highest yield (9.38 t/ha) followed by BRRI dhan89 (8.81 t/ha), BRRI Hybrid dhan2 (8.65 t/ha), BRRI dhan29 (8.37 t/ha), BRRI Hybrid dhan5 (8.26 t/ha), BR14 (8.23 t/ha), BRRI dhan92 (7.87 t/ha), BRRI dhan47 (7.55 t/ha).	Adaptation model of BRRI released rice varieties will be developed.
Program Area (05) : Technology Transfer		
5.1	Field demonstration of BRRI rice varieties: The yield of BRRI dhan75 and BRRI dhan87 were 4.15-5.90 and 5.15 - 6.60 t/ha respectively. Farmer's acceptance of BRRI dhan87 was found very high in those respective areas for its grain size panicle length and high yield. BRRI dhan81 (5.25 t/ha), BRRI dhan84 (6.18 t/ha), BRRI dhan89 (7.75 t/ha) and BRRI dhan92 (8.14 t/ha) performed better than rest of the varieties. The yield of BRRI hybrid dhan5 was ranged from 8.75 to 9.72 t/ha.	New high yielding rice varieties will be disseminated quickly and directly to the farmers.

Sl. No.	Research Progress	Expected Output
5.2	Varietal replacement through Head to Head (HTH) Trial during T. Aman 2019 &Boro 2019-20 Among the rice varieties used in this study, the yield of BRRI dhan87 showed the highest yield upto 6.54 t/ha compared to other rice varieties during Aman. BRRI dhan88 (upto 7.31 t/ha) showed highest yield followed by BRRI dhan67 (upto 6.99 t/ha), BRRI dhan81 (upto 6.92 t/ha), BRRI dhan84 (upto 6.41 t/ha) from short duration Boro varieties.	New high yielding rice varieties will be disseminated quickly and directly to the farmers.
5.3	Block demonstration, dissemination and quality seed production of rice varieties (SPIRA project) In T. Aman 2019, highest yield was obtained from BRRI dhan87 ranged from 5.15 to 6.60 t/ha followed by BRRI dhan 75 (4.78 t/ha). During Boro 2019-20, the average yield of BRRI dhan84, BRRI dhan89 and BRRI dhan92 were 6.39, 7.56, and 8.01 t/ha respectively.	New high yielding rice varieties will be disseminated quickly and directly to the farmers.
5.3	Training/Field day/Agricultural Fair	
5.3.1	Training on modern rice cultivation: Eight farmers' trainings (240 farmers) from GOB and 3 from SPIRA project (104 farmers and 16 SAAO) were conducted in different locations of Cumilla and Chandpur Districts.	Farmers knowledge on modern rice cultivation and technologies will be enhanced
5.3.2	Field day and Mela : Six field days were conducted in the block demonstration areas in Cumilla and Chandpur districts to demonstrate newly released BRRI varieties during Aman 2019 and Boro 2019-20 seasons which were funded by SPIRA project.	Farmers motivation on BRRI developed new technologies will be enriched.
5.4	Breeder and TLS seed production : In T. Aman 2019 and Boro 2019-20 seasons, a total of 32.48 (8.23 ton and 24.25 ton) ton breeder seeds and 41.422 ton TLS seeds of BRRI rice varieties were produced during the reporting year.	Quality seed demand of the seed companies, dealers and farmers will be fulfilled.

BRRI Regional Station, Habiganj

Table-2

Research progress 2019-20

Sl. No.	Research progress Programme area/project with duration	Expected output
Varietal Development		
Project I: : Improvement of B Aman and T Aman, 2019-20		
1	Secondary Yield Trial (SYT), Broadcast Aman (B. Aman)	Deep water rice genotypes; BR7733-2-1-2B, BR7735-1-1-2B and BR7920-1-2-3B produced 0.3 t ha^{-1} more yield over the check Hbj. Aman-I in SYT-1 and genotypes; BR7730-1-1-2B, BR7918-1-2-3B and BR7919-1-1-3B produced 0.9 t ha^{-1} more yield over the check Hbj. Aman-IV in SYT-2 during B. Aman.
2	Regional Yield Trial (RYT), Transplanted Aman (T. Aman)	Premium quality rice genotypes; BR9126-15-3-4-1 (4.2 t ha^{-1}) and BR9126-15-3-4-2 (4.0 t ha^{-1}) produced higher grain yield than all the checks (Kataribhog, Dinajpur Kataribhog and BRRI dhan37) within 135 days growth duration in RYT during T. Aman.
Project II: Transplanted Aman rainfed		
1	**Advanced genotypes in RYT-PQR**	Seven genotypes along with three checks Kataribhog, Dinajpur Kataribhog and BRRI dhan37 were evaluated. Genotypes; BR9126-15-3-4-1 (4.2 t ha^{-1}) and BR9126-15-3-4-2 (4.0 t ha^{-1}) produced higher grain yield with all the check varieties within 135 days growth duration

Project III: Irrigated Rice (Boro)		
1	Regional Yield trial (RYT) (ZER),	Zinc enriched rice genotype; BR8912-12-6-1-1-1-1 produced higher grain yield (7.7 t ha^{-1}) than all the check varieties (BRRI dhan28, BRRI dhan29, BRRI dhan74 and BRRI dhan84) in RYT during Boro.
2	Regional Yield trial (RYT) (PQR)	Premium quality rice genotype; BR8862-29-1-5-1-3 produced higher grain yield than all the tested varieties with 6-15 days later than the checks in RYT during Boro.
3	Regional Yield trial (RYT) (Insect resistant)	Insect resistance rice genotype; BR9891-11-2-2-20 (7.2 t ha^{-1}, 162 days) showed almost the same yield and growth duration with the check BRRI dhan58 (7.4 t ha^{-1}, 158 days) in the RYT during Boro.
4	RYT FB	The genotype TP29654 produced the highest yield among the tested entries that was about 1.5 t ha^{-1} more yield than the check BRRI dhan81 with same growth duration in the RYT#FB-1 during Boro.
5	RYT (FB-Biotechnology**)**	The genotype; BRC269-15-1-1-3 gave the highest grain yield (7.7 t ha^{-1}) than all the tested genotypes with similar

		growth duration (162 days) of the check BRRI dhan58 in the RYT#FB-2.
Sl. No.	**Research progress** **Programme area/project with duration**	**Expected output**
6	Effect of time of planting on growth, yield and yield contributing factors of some short duration rice varieties	With four different sowing times, all the tested advanced short duration genotypes gave higher yield in the sowing time of 5 December but BRRI dhan28 (ck) showed better yield in the 25 November.
Crop-Soil-Water Management		
1	Long-term missing element trial for diagnosing the limiting nutrient in soil.	Yield decrease was higher in NK and K omission plots followed by NPKSZn for long time (10 years).
2	Influence of nitrogen and potassium rates on performance of modern rice	Application of N @ 140 kg ha^{-1} with 50 kg K ha^{-1} BRRI dhan89 produced significantly higher grain yield of 7.48 t ha^{-1} than other combination of N and K fertilization during Boro in Habiganj Farm.
3	Greenhouse gas emission and global warming potential under triple rice cropping systems	Vermicompost organic manure during Aus, T. Aman and Boro rice cultivation could be very useful of atmospheric and soil management strategy for reducing about 14-97% global warming potential and increase rice yield about 5-17%.
4	Comparison of greenhouse gas emission under continuous flooding and AWD irrigation system	The Alternate wetting and drying irrigation system significantly reduced about 23-46% of total global warming potential than continuous flooding because of reducing methane emission rates.
5	Performance of grain yield and emission under newly rice verities at Sylhet regions.	BRRI dhan92 reduces about 7% CH_4 more emission than BRRI dhan29.
Seed production		
1	Truthfully labeled and Breeders Seed production	About 17 tons truthfully labeled seeds were distributed to the stakeholders from previous year's produce and more than 20 tons produced during the reporting year. About 26 tons breeders seeds were also produced and sent to the Genetic Resource and Seed Division.
Technology transfer		
1	Technology transfer and seed dissemination	The station conducted one special workshop for high officials of MoA, DAE and NARS Institutes. It has also trained 410 farmers and DAE personnel of Sylhet Region on rice production technology for submergence and cold environment.

Regional Station, Kushtia

Table-2

Research Progress 2019-20

Sl. No.	Research Progress	Expected output
VARIETAL DEVELOPMENT PROGRAMME AREA		
Aus, 2019		
1	Regional Yield Trial -Including 7 entries against 2 standard checks	BR9006-54-1-3-2 was found the highest yielder with over check variety BRRI dhan82
2	ALART Transplant Aus -Including 3 entries against one standard checks	The mega variety BRRI dhan48 (Ck) were comparatively better than other varieties
T. Aman, 2019		
3	Regional Yield Trial (RYT-1) Biotech. -Including 3 entries against one standard checks	All genotypes were 2-7 days earlier than BRRI dhan71(CK.) but not outyielded over the checks
4	Regional Yield Trial, BB, RTV & Blast Resistant Lines (RYT-2) -Including 6 entries against two checks	The standard check variety BRRI dhan87 performed better than the all tested lines
5	Regional Yield Trial, Insect Resistant Rice (IRR) (RYT-3) -Including 11 genotypes, two local and one standard check	Among the tested genotypes yielded almost similar and higher than all the local and standard checks.
6	Regional Yield Trial, Rainfed lowland rice (RLR-1) (RYT-4) - Seven genotypes and two standard checks	All the tested lines yielded lower than check variety BRRI dhan87
7	Regional Yield Trial, Rainfed lowland rice (RLR-2) (RYT-5) -Including 7 genotypes against two standard checks	One of the tested lines BR9574-15-3-4-2-1 gave significantly higher yield than check BRRI dhan87.
8	Regional Yield Trial, Drought Tolerant Rice (DTR) (RYT-6) -Including 9 genotypes and three standard checks	None of the tested lines performed significantly higher than checks
9	Regional Yield Trial, Zinc enriched rice (ZER) (RYT-7) -Including 6 genotypes and two standard checks	None of the advanced lines yielded significantly higher than checks
10	Regional Yield Trial, Premium Quality Rice (PQR) (RYT-8) - Seven genotypes, two local and one standard check	Among seven genotypes BR8887-26-8-2-3 significantly outyielded over local and standard checks with a short growth duration
11	Advanced Line Adaptive Trial (ALART) Biotechnology -Including 2 advanced lines along with two standard check	Emerging mega variety BRRI dhan87(ck.) outyielded both of the tested lines
12	ALART Rainfed Lowland Rice (RLR) - Including 4 advanced lines along with 2	None of the tested lines yielded higher than BRRI dhan87 (ck.)

Sl. No.	Research Progress	Expected output
	standard checks	
13	ALART Zinc Enriched Rice (ZER) -Including 3 advanced lines along with 3 standard checks	BR8436-7-4-2-3-1 yielded higher than checks but lower than zinc rice BRRI dhan72
Boro, 2019-20		
14	Regional Yield Trial 1, Favorable Boro Rice (FBR) -Including 10 entries along with three checks	BR8899-17-1-1-1-1-1 out-yielded over check variety BRRI dhan81
15	Regional Yield Trial 2, Favorable Boro Rice (FBR)-Including six entries along with two check varieties	The two checks performed better well and none of the tested lines showed significant difference over checks
16	Regional Yield Trial, Insect Resistant Rice (IRR) -Including six genotypes were tested against two susceptible checks	Among the tested lines BR9891-18-1-2-7 was found highest yielder over the checks and others genotypes
17	Regional Yield Trial, Premium quality rice (PQR) -Including Four genotypes against 3 checks	Among the tested genotypes, BR8526-38-2-1-HR1 was the highest yielder
18	Regional Yield Trial, Zinc enriched rice (ZER) -Including 3 genotypes and four standard checks	Among the tested lines BR8912-12-6-1-1-1-1 yielded higher than all of check varieties
19	Regional Yield Trial, Favorable Boro Rice Cumilla (FBR) - Including 5 genotypes and three standard check	The tested lines (BRC302-2-1-2-1 and BRC269-15-1-1-3) performed better than all of checks
20	ALART Premium Quality Rice (PQR) -Including 2 advanced lines along with one standard check	None of the premium genotypes yielded higher than the popular variety of BRRI dhan50 (ck.)
21	ALART Zinc Enriched Rice (ZER) -Including One advanced lines against two standard checks	The tested line IR99285-1-1-1-P2 yielded higher than check BRRI dhan84
CROP-SOIL-WATER MANAGEMENT		
22	Determining Minimum Irrigation Water Requirement of Rice in Different Regions through Water Balance from On-farm Demand and Model Simulation -Including 3 treatments and with four replications	Among the tested treatments, Continuous standing water was found the highest yielder with statistically significant yield difference with AWD condition (15 cm) and Simulated irrigation schedule by CROPWAT Model
SOCIO ECONOMICS AND POLICY PROGRAMME AREA		
23	Stability analysis of BRRI varieties both T. Aman and Boro season -Including T. Aman and Boro were 42 and 43 respectively	Among forty two (42) varieties the highest yielder was BRRI hybrid dhan6 and forty three (43) tested varieties the highest yield was obtained by BRRI Hybrid dhan3 in T. Aman and Boro season respectively.
RICE FARMING SYSTEM PROGRAMME AREA		
24	Validation of High Intensity Cropping Pattern for Kushtia	Maize+Potato – T. Aus –T. Aman pattern produced highest rice equivalent yield.
TECHNOLOGY TRANSFER PROGRAM AREA		

Sl. No.	Research Progress	Expected output
25	Farmers training both T. Aman and Boro season - a total of 13 batches of 700 farmers' trained	Modern rice varieties and relevant technologies were disseminated through training
26	Demonstration trial both T. Aman and Boro season - A total of 36 demonstrations of the BRRI released HYVs	Modern rice varieties and relevant technologies were disseminated through field demonstration
27	Field days -A total of seven field days conducted	Modern rice varieties and relevant technologies were disseminated

Regional Station, Rajshahi

Table 2

Research Progress: 2019-2020

Research Progress	Expected output
1. Program Area: Crop Soil Water Management	
1.0 Nutrient management under conservation agriculture (CA) in a double rice cropping system Under puddled condition, 75% of the recommended fertilizer was enough for BRRI dhan75 cultivation. In Boro season, 25% extra fertilizer application significantly increased the grain yield of BRRI dhan88.	Production cost would have reduced and grain yield could be increased
1.2 Suitable and profitable nutrient management for rice in Barind Tract soils For BRRI dhan71cultivation, AEZ based fertilization gave more yield than nutrient expert (NE) and rice crop manager (RCM).	Grain yield would be increased
1.3 Determination of yield-limiting nutrients in soils by omission plot technique In T. Aman, N was found as the most yield-limiting nutrient followed by P and K. In Boro season, N omission resulted in the lowest rice yield of BRRI dhan63 followed by K.	Can be applicable for balanced fertilization
1.4 Response of T. Aman and Boro rice to applied nitrogen in Barind Tract and calcareous soil The calculated rate of N that maximizes the yield of BRRI dhan87 was 96 kg/ha for AEZ 26 and AEZ 11. Nitrogen rates for BRRI dhan81 were found enough 150 kg/ha for AEZ 26 and 125 kg/ha for AEZ 11.	Grain yield could be increased
1.5 Response of T. Aman and Boro rice to applied phosphorus in Barind Tract and calcareous soil The calculated rate of P that maximizes the yield of BRRI dhan87 was 21.8 kg/ha for AEZ 26 and AEZ 11. Phosphorus rates for BRRI dhan81 were found enough 30 kg/ha for AEZ 26 and 20 kg/ha for AEZ 11.	
1.6 Response of T. Aman and Boro rice to applied potassium in Barind Tract and calcareous soil The calculated rate of K that maximizes the yield of BRRI dhan87 was 98.7 kg/ha for AEZ 26 and 91.9 kg /ha for AEZ 11. Potassium rates for BRRI dhan81 were found enough 125 kg/ha for AEZ 26 and 75 kg/ha for AEZ 11.	Grain yield could be increased Grain yield could be increased

Research Progress	Expected output
1.7 Response of T. Aman and Boro rice to applied zinc in Barind Tract and calcareous soil The calculated rate of Zn that maximizes the yield of BRRI dhan87 was 1.3 kg/ha for both AEZ 26 and AEZ 11. Zinc rates for BRRI dhan81 were found enough 2.0 kg/ha for AEZ 26 and 1.5 kg/ha for AEZ 11.	Grain yield could be increased
10.8 Response of T. Aman and Boro rice to applied boron in Barind Tract and calcareous soil The calculated rate of B that maximizes the yield of BRRI dhan87 was 1.25 kg/ha for both AEZ 26 and AEZ 11. Boron rates for BRRI dhan81 were found enough 1.5 kg/ha for both AEZ26 and AEZ11.	Grain yield could be increased
1.9 Effect of nitrogen and potassium rates on rice cultivation The suitable combination of N and K for BRRI dhan49 was 50 kg N and 40 kg K/ha. On the other hand, this combination for BRRI dhan29 was 150 kg N and 40 kg K/ha.	Can be applicable for balanced fertilization and higher yield
2. Program Area: Varietal Development 2.1 Regional Yield Trial (RYT#1), T. Aus 2019 Out of 10, four entries appeared promising. 2.2 Proposed Variety Trial (PVT), T. Aus 2019 The advanced breeding lines coded by I-003 performed higher grain yield than I-004. 2.3 Observational Yield Trial (OYT), T. Aus 2019 In total, 257 advanced breeding lines along with the standard check BRRI dhan48 were evaluated. Among these, 2 genotypes gave more than 6 t/ha grain yield. 2.4 Hybridization, T. Aman 2019 For development of drought tolerant rice, a total of 855 F_1 seeds were produced from ten crosses using nine parents. 2.5 Regional Yield Trial (RYT), T. Aman 2019 A total of 56 breeding lines were evaluated in eight different RYT. Among these genotypes, 6 entries found promising for further advancement. 2.6 Proposed Variety Trial (PVT), T. Aman 2019 The breeding lines coded by I-005 showed 0.96 t/ha higher grain yield with 13 days' longer growth duration over the genotypes I-007 whereas another line coded by I-008 produced 0.55 and 1.75 t/ha higher grain but 4 and 19 days longer growth duration over the genotypes coded by I-006 and I-009 respectively.	. These line could be used for further advancement This line released as B. Aus variety. These line could be used for further advancement These F1 seeds could be used for further advancement This line could be used for further advancement This line could be released as variety.
2.7 Observational yield trial (OYT) of Breeding Zone Trial, T. Aman 2019 A total of 384 advanced lines were evaluated in which 48 tested entries produced higher grain yield than the all check varieties The highest grain yield was produced by the genotype IR17A2129 (7.61 t/ha). 2.8 Observational yield trial (OYT) of AGGRi Network Trial, T. Aman 2019 For drought ecosystem, 300 advanced lines were evaluated under control and stress conditions of which eighteen genotypes were selected. 2.9 International Rainfed Lowland Observational Nursery (IRLON), Set-19, T. Aman 2019	Better genotypes could be used for further advancement. Better genotypes could be used for further advancement. Better genotypes could be used for further advancement.

Research Progress	Expected output
A total of 95 genotypes against five standard checks; BRRI dhan49, BRRI dhan56, BRRI dhan66, BRRI dhan71 and BRRI dhan87 were evaluated.	Better genotypes could be used for further advancement.
2.10 Preliminary Yield Trial (PYT), Disease Resistance Rice (BB), T. Aman 2019, TRB-BRRI project A total of 14 advanced breeding lines along with IRBB60 as resistant check and BRRI dhan33, BRRI dhan49 and BRRI dhan87 as susceptible checks were evaluated. The genotype BR10401-5-3-2-1 (5.16 t/ha) produced similar grain but 3 days shorter growth duration than the check variety BRRI dhan87 (5.28 t/ha).	Better genotypes could be used for further advancement.
2.11 Breeding Value Estimation (BVE) of Rice Elite Breeding Pool, T. Aman 2019, TRB-BRRI project A total of 228 genotypes/varieties were evaluate. Among them, BRRI dhan73 produced the highest grain yield (5.35 t/ha) followed by BR 7879-17-2-4-HR3-P1 (5.09 t/ha). Due to heavy rainfall (Bulbul) most of the entries were lodged, as a result grain yield was reduced.	The seeds could be advanced for variety
2.12 Hybridization, Boro 2019-20 A total of 1145 F1 seeds were produced from twenty-five crosses using eleven parents in Boro 2019-20 season.	The crosses could be advanced for variety
2.13 F_1 Confirmation, Boro 2019-20 Out of 10 crosses, five crosses were selected and confirmed as true F_1s. Seeds of these selected F_1 plants were selfed to produce F_2 seeds.	These progenies could be advanced for variety
2.14 Rapid generation advance of segregating nurseries, Boro 2019-20 In total, 57 individual progenies were harvested from F2 generations through FRGA method.	
2.15 Regional Yield Trial (RYT), Boro 2019-20 During Boro, 7 RYTs with 44 breeding lines were conducted of which 7 lines found promising for further advancement.	Better genotypes could be used for further advancement.
2.16 Observational yield trial (OYT) of Breeding Zone Trial, Boro 2019-20 In BZT, 354 RGA derived advanced breeding lines were evaluated. The highest grain yield was produced by the genotype IR17A2076 (7.91 t/ha and 143 days) followed by IR17A1544 (7.78 t/ha and 148 days).	Better genotypes could be used for further advancement.
2.17 Observational yield trial (OYT) of Heat Tolerance Rice under AGGRi Network Trial, Boro 2019-20 A total of 300 advanced lines along with 12 local and global checks were evaluated under heat stress conditions. The genotype IR82589-B-B-84-3 produced the highest grain yield (6.60 t/ha and 129 days) followed by IR66946-3R-149-1-1 (5.88 t/ha and 130 days).	Better genotypes could be used for further advancement.
2.18 Observation Yield Trial (OYT)-Favorable Boro Rice (FBR) and Cold Tolerant Rice (CTR), Boro 2019-20, TRB-BRRI project A total of 435 advanced breeding lines along with the six standard check varieties BRRI dhan28, BRRI dhan29 BRRI dhan58, BRRI dhan69, BRRI dhan81and BRRI dhan89 were. The seven entries viz. BR10595-5R-194, BR10604-5R-97, BR10623-5R-86, BR10623-5R-89, BR11303-5R-10, BR11303-5R-108 and BR9945-5R-119 were performed more than 9 t/ha grain yield (9.98-9.12 t/ha and 145-153 days).	Better genotypes could be used for further advancement.
2.19 Observational Yield Trial (OYT), Disease Resistance Rice (BB),	

Research Progress	Expected output
Boro 2019-20, TRB-BRRI project In OYT-BB, a total of 172 advance breeding lines were evaluated and one entry gave more than 6 t/ha. 2.20 Preliminary Yield Trial (PYT)-Disease Resistance Rice (BB), Boro 2019-20, TRB-BRRI project Ten advanced breeding lines were evaluated in PYT-BB of which one entry produced more than 8 t/ha grain yield.	Better genotypes could be used for further advancement. Better genotypes could be used for further advancement.
3.0 Program Area: Rice Farming Systems 3.1 Evaluation of crop productivity and soil health under four crops cropping patterns in Rajshahi region In four crops cropping pattern trial, the (rice equivalent yield) REY remained higher in Mustard-Onion/Maize (relay)-T. Aman (BRRI dhan75) pattern followed by Mustard-Onion-T. Aus-T. Aman (BRRI dhan75) pattern. 3.2 Evaluation of crop productivity and soil heath under strip tillage system in maize-mungbean-rice cropping pattern Considering cropping system yield, REY as well as gross return and margin were found higher in strip tillage un-puddled rice through rice transplanter followed by strip tillage maize and mungbean. 3.3 Effects of urea application techniques on different Boro varieties in Barind region The similar grain yield was found in urea applicator and urea broadcast method although 20% less urea was applied in urea applicator method.	Productivity and profitability of the farmers will be increased. Productivity and profitability of the farmers will be increased and soil health will be maintained 20% urea could be saved and farmers will be benefitted.
4.0 Program Area: Pest Management 4.1 Effect of selected insecticide for stem borer management Among the tested insecticides, Fipronil 50SC found superior followed by Cartap 50SC. 4.2 Species composition of stem borer in Rajshahi region Among the species of stem borer, the highest number was dark headed borer followed by yellow stem borer and lowest was pink borer (54.84%, 43.67% and 1.49% respectively). 4.3 Effect of different trap design for the management rat Significantly higher number of rats were captured in bamboo types traps than box type and snap type traps	Appropriate insecticide could be used to control stem borer Appropriate insecticide could be used to control stem borer Using bamboo trap could reduce cost and control rats effectively
5.0 Program Area: Socioeconomics and Policy 5.1 Stability Analysis of BRRI developed T. Aman rice varieties Forty-three Aman rice varieties were evaluated at BRRI regional station, Rajshahi farm. Among them, BRRI hybrid dhan4 were top in ranked in terms of yield (6.36 t/ ha) followed by BRRI dhan87 (6.13 t/ha), BRRI hybrid dhan6 (5.98 t/ha) and BRRI dhan72 dhan49 (5.97 t/ha). Variety BRRI dhan37, BRRI dhan62, BRRI dhan5 and BRRI dhan38 were found low yielding varieties and the yield ranging from 3.26 to 3.68 t/ ha. 5.2 Stability Analysis of BRRI developed Boro rice varieties Forty-two Boro rice varieties were evaluated at BRRI regional station, Rajshahi farm. Top three varieties were hybrid dhan5 (7.29 t/ha), BRRI hybrid dhan2 (7.24 t/ha) and BRRI dhan29 (7.22 t/ha). BRRI dhan17	Suitable and stable variety could be selected for this region Suitable and stable variety could be selected for this region

Research Progress	Expected output
and BRRI dhan45 were the low yielding (4.61 t/ha) among the Boro varieties.	

Regional Station, Satkhira

Table-2
Research Progress 2019-20

Sl. No.	Research Progress	Expected output
01	**Varietal Development Program (VDP)** In T. Aman 2019, under regional yield trial (RYT) for saline tolerant rice, the entries BR9743-5-7-10, IR112453-B-BAY10-3-1 and TP30642 gave higher yield than check varieties. In RYT for ZER, BR10001-94-2-B, BR7528-2R-19-16-RIL-33 and BR7528-2R-19-16-RIL-59 entries produced higher yield over BRRI dhan72. In Boro 2019-20, under RYT for FBR, tested genotypes of IR100004-19-B-1 and BR8902-38-7-1-1-1-1 had significant yield advantage than BRRI dhan81. In RYT for PQR, Habubalam performed better over the check of BRRI dhan50. In RYT for ZER, the entry IR105837-8-95-2-1 performed better than the three checks of BRRI dhan28, BRRI dhan74 and BRRI dhan84. In RYT for saline tolerant rice, the entries BR9626-B-2-3-15, BR9621-B-2-3-22, BR9627-1-3-1-10, IR104002-CMU28-CMU1-CMU3 and BR9620-2-4-1-5 gave higher yield than the check varieties of BRRI dhan28, BRRRI dhan67 and BINAdhan-10. In T. Aman 2019, for ALART-BIO, none of the entries performed better than the check of BRRI dha87, while all of the entries gave higher yield than the check of BRRI dhan71. In ALART-ZER, none of the entries performed better than the check varieties of BRRI dhan87 and BRRI dhan72, where the entry BR8442-12-1-3-1-B7 produced higher yield than BRRI dhan49. In Boro 2019-20, for ALAR-ZER, the entry IR99285-1-1-1-P2 gave higher yield than the check BRRI dhan84. In ALART-BBRR, all the entries, except BR(Bio)11447-3-10-7-1 gave higher yield over the check variety of BRRI dhan28, while none of the entries performed better than the check variety of BRRI dhan58.	Selected lines could be used for further advancement. The tested lines might be released as variety.
02	**Crop-Soil-Water Management** In T. Aus 2019, application of 80 kg N ha^{-1} were found optimum dose for higher yield irrespective of variety. For irrigation experiment, when water level was 15 cm below form the surface resulted in the highest yield for BR26 and BRRI dhan82, while BRRI dhan48 performed better in rainfed condition. In T. Aus season, transplanting on 10 May gave the highest yield. Nitrogen is the most critical yield limiting nutrient and balanced	Productivity and profitability of the farmers will be increased. Option for saline

Sl. No.	Research Progress	Expected output
	fertilizer application needed for getting maximum yield as well as maintain soil health. Combined application of ash and manure @ 2.5 t ha^{-1} + 70% BRRI recommended fertilizer (RF) could be a good fertilizer management option for increasing rice yield in saline soil. However, application of increased N (20%) and K (60%) from the recommended dose of N (124 kg ha^{-1}) and K (60 kg ha^{-1}) increased rice yield in saline soil. Foliar application of FLORA did not appear as profitable for rice cultivation at Satkhira.	management.
03	**Socio Economic and Policy** BRRI dhan48 among the Aus varieties, while in T. Aman, most of the tested varieties and among the Boro varieties, BRRI hybrid dhan3, BRRI hybrid dhan5, BRRI dhan67 and BRRI dhan89 appeared as good yielder in stability analysis at BRRI farm, Satkhira. BRRI hybrid dhan5 gave the highest yield over the other tested hybrid rice varieties at Debhata and Assasuni of Satkhira district in Boro 2019-20 season.	Dissemination of newly released BRRI varieties and rice production technologies.
04	**Technology Transfer** In integrated rice-fish culture, BR10 performed better (5.13 t ha^{-1}) than BRRI dhan73 (4.30 t ha^{-1}), while BR10, BRRI dhan30 and BRRI dhan79 produced similar yield (5.15-5.35 t ha^{-1}) under stagnant water environment. Under head to head trail, irrespective of locations, BRRI dhan87 gave the highest yield (6.69 t ha^{-1}) followed by BRRI dhan49 (5.83 t ha^{-1}) during Aman 2019.	Productivity and profitability of the farmers will be increased
05	**Breeder and Truthfully Labelled Seed Production** A total of 28.11 tons of breeder seed of different T. Aman and Boro rice varieties were produced and sent to the GRS division. In addition, 32.06 tons of truthfully labelled seed of different Aus, Aman and Boro rice varieties were produced, stored, sold and distributed to the farmers, NGOs and DAE as well.	Production of breeder seed to meet up the demand of BRRI HQ. Dissemination of newly released BRRI varieties and rice production technologies.

Regional Station, Sonagazi, Feni

Table-2

Research Progress 2019-2020

Sl. No	Research Progress	Expected output
Programme area/Project with duration: Regional Station, 2019-20		
1	**Varietal development**	
	i) Regional yield trial (RYT): Regional Yield trials (RYT) were conducted at experimental field of BRRI, Sonagazi to test the yield performance of superior breeding lines. A total of 106 breeding lines were tested under this trial during the reporting period from which	Selection of region based suitable advanced breeding lines and better

Sl. No	Research Progress	Expected output
	nine lines were found better than checks regarding grain yield and yield contributing characters. Breeding lines were supplied from Plant breeding and Biotechnology divisions. Ten lines along with standard checks BR26, BRRI dhan48 and BRRI dhan82 were tested during Aus from which two advanced lines BR8781-16-10-3B and BR9006-54-1-3-2 were recommended for advanced trial. During T. Aman season two Rainfed Lowland Rice (RLR), one Zinc Enriched Rice (ZER), one high yielding Rice (HYV), one drought tolerant Rice (DTR), One disease resistant Rice (DRR) were evaluated under on-station condition from which Seven RYT were supplied from Plant breeding division and one RYT were supplied from Biotechnology division. The DRR lines BR10397-4-1-2 were selected for advance trial. The RLR lines BR9571-13-1-9-1-1 and BR9573-31-1-2-5-1 were selected for advance trial. On the basis of growth duration, yield and yield contributing characters the ZER advanced line BE10001-94-2-B were found better than check variety. No line from DTR and HYV (Biotechnology) were selected for advance trial during Aman, 2019. During Boro 2019-20 Favorable boro rice (FBR) BRC-297-15-1-1-1 & BRH9-7-4-1B and Premium quality rice (PQR) BR8526-38-2-1-HR1 **l**ines were selected for advance trial.	genotypes would be used for further advancement as Advanced Line Adaptive Research Trial (ALART).
	ii) Advanced Lines Adaptive Research Trial (ALART): ALARTs were conducted during T. Aus, 2019 in Sonagazi, Feni which had four genotypes including one standard checks BRRI dhan42, BRRI dhan43, BRRI dhan83 and BRRI dhan48 (Ck). Three categories of ALARTs were conducted during T. Aman, 2019 such as, Rainfed Lowland Rice (RLR), Zinc Enriched Rice (ZER) and ALART Biotechnology. The trials were conducted at Fulgazi, Feni. Five categories of ALARTs were also conducted during Boro 2019-20 season such as PQR, ZER, IRR, BRR and BBRR at Fulgazi, Feni. All recommended and suggested agronomic management practices were provided in the trials. Data were collected on yield and yield contributing characters, phenotypic acceptance at vegetative and reproductive stage, insect and disease reaction and lodging records. Collected results with reports were submitted to adaptive research division of BRRI, head quarter which were analyzed and reported.	Well performed lines could be used as **Proposed variety trials** (PVT).
Sl. No	**Research Progress**	**Expected output**
2	**Pest Management**	
	i) Survey and monitoring of rice diseases: Survey was carried out at farmers' fields of Laxmipur, Noakhali, Feni, Cox'sbazar, Chattogram and Khagrachari districts both in T. Aman, 2019 and Boro, 2019-20. Sites were selected with the suggestion and collaboration of Upazila Agricultural Officer (UAO) of Department of Agricultural Extension (DAE). Sub Assistance Agricultural Officer (SAAO) of concern block helped in site selection who were the front line workers and very much familiar to the farmers as well as their fields. Bacterial Leaf Blight (BLB), Bacterial Leaf Streak (BLS), Sheath rot, False smut and Sheath blight infestation were observed in different scores during T. Aman season. BRRI dhan49	A precautionary measures against rice diseases will possible.

Sl. No	Research Progress	Expected output
	were affected by false smut disease in different locations due to fluctuation of environmental conditions during Aman season. BRRI dhan28 and BRRI dhan29 were affected moderately by blast during Boro season. Others were also affected in different degrees such as BRRI dhan58, BRRI dhan67 and BRRI dhan81. The farmers were suggested for preventive measures using fungicide.	
	Monitoring of insect pests and natural enemies by using light trap: Rice insect pests and their natural enemies were monitored throughout the reporting period by Pennsylvanian light traps from July 2019 to June 2020 at the experimental field of BRRI regional station, Sonagazi, Feni. The abundance of leaf roller (LR), Stem borer (SB), Rice bug (RB), green leafhopper (GLH), grasshopper (GH), Mole cricket (MC), Field cricket (FC), and stink bug (SB) were found in the light trap during the reporting period.	A data base of insect population may be produced.
3	**Socio-Economics and Policy**	
	Stability analysis of BRRI released HYVs of rice: Ten Aus rice varieties were evaluated during Aus, 2019 at BRRI regional station, Sonagazi farm. Among them, BRRI Hybrid dhan48 ranked top in terms of yield (5.34 t ha^{-1}) followed by BRRI dhan82 (4.68 t ha^{-1}). Variety BR21, BRRI dhan24, BRRI dhan65 were found low yielding varieties and the grain yield 2.88, 3.22 and 3.27 t/ha^{-1} respectively. Forty two Aman rice varieties were evaluated during Aman, 2019 at BRRI regional station, Sonagazi farm. Among them, BRRI Hybrid dhan4 ranked top in terms of yield (6.51 t ha^{-1}) followed by BRRI dhan87 (6.48 t ha^{-1}). Variety BR5, BRRI dhan38, BRRI dhan57 were found low yielding varieties and the yield ranging from 3.05 to 3.53 t ha^{-1}. Forty three Boro varieties were evaluated during Aus, 2019 at BRRI regional station, Sonagazi farm. Among them, BRRI Hybrid dhan5 ranked top in terms of yield (8.37 t ha^{-1}) followed by BRRI Hybrid dhan2 (7.93), BRRI dhan92 (7.84 t ha^{-1}) and BRRI dhan74 (7.16 t ha^{-1}). BR2 and BR17 were the low yielding varieties and the grain yield were 3.86 to 4.15 t ha-1.	Region basis suitable rice varieties would be identified
4	**Technology transfer**	
	i) Seed Production and Dissemination Program (SPDP): **During T. Aus, 2019:** The demonstrations were conducted in 11 upazilas of six districts (Noakhali, Feni, Chattagram, Rangamati, Bandorban and Khagrasori) during T. Aus 2019. BRRI dhan48, BRRI dhan65, BRRI dhan82 and BRRI dhan83 were used as cultivar in those Upazilas considering land suitability and seed availability. The demonstration area of each upzila was 1/2 bighas belonging of more than one farmer. A detailed research program along with primary and final data sheets were sent to concern Upazila Agriculture Office before conducting the trial. Seeds, fertilizers and signboards were supplied from BRRI, Sonagazi for the demonstrations. Data on growth duration, grain yield, total	Farmers would be motivated to cultivate HYVs of rice developed by BRRI and Rapid dissemination of BRRI released varieties among the farmers.

Sl. No	Research Progress	Expected output
	production, retained seeds, knowledge sharing and motivated farmers were recorded. The highest grain yield was found in BRRI dhan48 (5.45 t/ha) at Mirsori upazila of Chattogram district followed by BRRI dhan82, BRRI dhan83 and BRRI dhan65. A total 9500 kg seeds produced in demonstrated areas from which 2825 kg seeds were retained by the farmers for next year cultivation. The knowledge gained farmers were 1715 and motivated farmers were 1945 who decided for next year cultivation. **During T. Aman, 2019:** The demonstrations on SPDP were conducted in 16 upazilas of 8 districts of jurrisdicted areas of BRRI regional station, Sonagazi during T. Aman season under core program. BRRI dhan41, BRRI dhan44, BRRI dhan46, BRRI dhan71, and BRRI dhan87 were used as cultivar in different upazilas considering land suitability, agro-ecology and seed availability. A total of 39 demonstrations were conducted in 53 farmers' fields having two bighas of each variety. The total seed production of BRRI dhan41, BRRI dhan44, BRRI dhan46, BRRI dhan71 and BRRI dhan87 were 4325 kg, 4066 kg, 2890 kg, 3024 kg and 1420 kg respectively whereas retained seeds were 1512 kg, 1180 kg, 2150 kg, 1285 kg and 551 kg of those varieties respectively. The demonstrations on SPDP were conducted in 3 Upazilas of 3 districts of jurrisdicted areas of BRRI regional station, Sonagazi during T. Aman season under SPIRA project. BRRI dhan71 and BRRI dhan87 were used as cultivar in those upazilas considering land suitability, agro-ecology and seed availability. The total seed production of BRRI dhan71 and BRRI dhan87 were 5350 kg and 6560 kg whereas retained seeds were 3050 kg and 4120 kg of those varieties respectively. **During Boro season, 2019-20:** The demonstrations on SPDP were conducted in 05 Upazilas of 4 districts of jurrisdicted areas of BRRI regional station, Sonagazi during Boro season under core program. BRRI dhan58 and BRRI dhan67 were used as cultivar in different upazilas. A total of 20 demonstrations were conducted in farmers' fields having two bighas of each variety. The total seed production of different varieties were 25500 kg and farmers retained 13450 kg of seeds for next year cultivation and distribution to other interested farmers. The knowledge gained farmers were 8500 and motivated farmers were 5500 for different varieties demonstrated in farmers fields. The demonstrations on SPDP were conducted in 3 Upazilas of 3 districts (Feni, Laxmipur and Noakhali) of BRRI regional station, Sonagazi during Boro, 2019-20 season under SPIRA project. BRRI dhan67 and BRRI dhan74 were used as cultivar in those upazilas. The total seed production of BRRI dhan67 and BRRI dhan74 were 15050 kg and motivated farmers were 2337 for those varieties demonstrated in farmers fields.	

Sl. No	Research Progress	Expected output
	ii) Varietal replacement through Head to Head Adaptive trial under TRB Project during Aman, 2019: Five varietal demonstrations were conducted under four Upazilas of Feni (Sonagazi, Fulgazi, Dagonbhuiyan) and Chattagram (Mirsorai) districts during Aman, 2019. Five varieties viz BRRI dhan49, BRRI dhan71, BRRI dhan75, BRRI dhan80 and BRRI dhan87 were used in this adaptive trial. BRRI dhan87 yielded higher (6.01-6.16 t ha^{-1}) in almost all locations followed by BRRI dhan49 & BRRI dhan71.	Maximizing rice yield by adopting BRRI release latest varieties
	iii) Farmers Training: Farmers' trainings were arranged in Noakhali, Feni, Chattagram, Coxes bazar and Rangamati districts with the collaboration of DAE as an important tool to train up farmers on updated modern rice cultivation technologies and to encourage them to adopt modern rice varieties with associated technologies. A total number of 13 farmers trainings on "Modern Rice production technology" were conducted in five different districts during the reporting period. In every batch of farmers training 40 farmers and 10 DAE field stuffs participated in which they were trained up with rice production technology in different ecosystem especially on tidal submergence, salinity and favorable environment. A total of 520 farmers and DAE staffs were trained during the reporting period.	Capacity building and Awareness for adopting improved rice cultivation technologies of farmers.
	iv) Field Day: Field days were arranged for awareness building and create interest among the farmers and concerned extension agents about the modern rice production technologies. These aided in wide publicity and familiarity of the institute, our technologies and BRRI's contribution towards national economy. About 150-200 persons (farmers, researchers, extension service providers, local leaders, public representatives and administrative people etc.) were invited in a field day. A total of 12 field days were arranged during Aus, T. Aman & Boro season. Nearly 2650 progressive farmers, local leaders, DAE field stuff, public representatives & NGO workers participated in those occasions.	Awareness for adopting improved rice cultivation technologies would be grown
5	**Enrichment of Seed Stock**	
	i) Breeder seed production: Nucleus seeds were supplied from Genetic Resources and Seed (GRS) Division for breeder seed production during Aman and Boro seasons. BR11, BRRI dhan34, BRRI dhan41 and BRRI dhan80 were cultivated during Aman season whereas BRRI dhan28 and BRRI dhan29 during Boro season. A total of Breeder seed during Aman and Boro were 8.5 tons and 6.5 tons respectively. All produced seeds were sent to GRS division of BRRI, Gazipur	Enrichment of breeder seed stock.
	ii) Truthfully labeled seeds (TLS) production: Truthfully labeled Seed (TLS) production activities were undertaken at BRRI research field during Aus, 2019, Aman 2019 and Boro 2019-20. This seed production category was an easy way without any supervision of SCA but quality was maintained providing our own facilities and declared truthfully. Seeds were produced as per physical and technical capacity, opportunity and local need of BRRI, Sonagazi. As	Increasing the availability of seed for farmers use.

Sl. No	Research Progress	Expected output
	a result, farmers purchased the seeds of BRRI released varieties. Seeds were also purchased by different organizations. Total production of TLS during Aus, Aman and Boro were 1529 kg, 6955 kg and 1000 kg respectively.	

Regional Station, Rangpur

Table-2

Research progress, 2019-2020

Sl. No.	Research Progress Program area/Project (Duration)	Expected output
Varietal Development program		
1.0	Development of Second Generation Rice (SGR)	
1.1	Germplasm collection and Hybridization	5 germplasm were collected and 21 crosses were made
1.2	F1 Confirmation	4 crosses were confirmed
1.3	Observational yield Trial (OYT)	100 genotypes were selected for further evaluation
1.4	Maintenance and seed increase of parents/lines/land races	To maintain local and modern rice variety as germplasm for breeding
2.0	Breeding for standard rice varieties for Rangpur region	
2.1	Field RGA (F4)	8000 individual plants were selected from Field RGA
2.2	Secondary Yield Trial (SYT) of BRRI dhan49 NILs	07 genotypes were selected for further evaluation
3.0	Development of Medium stagnation and submergence Tolerant Rice (MSSTR)	
3.1	Germplasm collection and Hybridization	7 germplasm were collected from different sources and 5 crosses were made
4.0	Breeding for Photoperiod-sensitive rice varieties (PSR) for lowland and Charland ecosystem	
4.1	Germplasm collection and Hybridization	10 germplasm were collected and 12 crosses were made
CROP-SOIL-WATER MANAGEMENT		
1.1	Yield maximization of BRRI dhan71 through adjustment of plant population and seedling age at variable time of planting	Higher yield was observed at 15 August planting with all seedling age irrespective of spacing under yield maximization experiment of BRRI dhan71
1.2	False smut disease management of BRRI dhan49 through adjustment of N and K ratio at variable time of planting	False smut disease incidence was lower at early planting (15 July) then it increases with time. Relatively higher incidence was observed with Mg_1 and it similar incidence was observed with Mg_2 & Mg_3.
1.3	Effect of N and K fertilizer management on growth and yield of mechanically transplanted Boro rice	By rice transplanter, BRRI dhan89 produced about 0.7 t/ha higher yield with Mg_2 and Mg_3 over Mg_1 due to produced more number of grain and panicle and

Sl. No.	Research Progress Program area/Project (Duration)	Expected output
	in light textured soil of Rangpur	Mg_3 is better than Mg_2 in light textured soil in Rangpur Region.
1.4	Effect of polythene cover on seedling quality and it's carryover effect on field duration and yield	For quality seedling raising in boro season, there was no significant difference in grain yield among polythene cover treatments but day-night polythene cover (T_3) reduces growth duration by 2-3 days over other treatments. Treatment T_3 is farmers' friendly because it is hassle free, a few labor consuming (cost effective) and risk free.
1.5	Effect of aged seedling on yield of Boro rice in northern region of Bangladesh	In Rangpur region, BRRI dhan88 and BRRI dhan89 produced similar grain yield with all seedling age (35-65 days) in Boro season. Although total growth duration was higher in A_{65} but field duration was lower than younger seedling but produced similar grain yield.
1.6	Yield Maximization of Boro Rice under different management options at variable time of planting	All tested varieties (BRRI dhan84, BRRI dhan88 and BRRI dhan89) produced higher yield at 25 January planting except BRRI dhan89. It gave slightly higher yield at 15 February planting. All varieties produced about 0.5 t/ha higher yield with Mg_1 than Mg_2 and Mg_3.
1.7	Effect of Zinc management on uptake pattern of BRRI dhan84	Zink sulphate (10kg/ha i.e. Z_1 produced little higher yield than other Zn management (<15% than Zn_1) options. Uptake of Zn not yet completed.

Regional Station, Gopalganj

Table-2
Research Progress 2019-2020

SL.NO.	Research Progress	Expected Output
	Programmed Are/ Project (Duration)	
	It is a new station, The station Started journey in 16.04.2019 with a single man power. No research program and progress yet during 2019-20.	

Regional Station, Sirajganj

Table-2
Research Progress 2019-2020

SI. No.	Programme area/ Project (Duration)	Expected output
1	**Survey & Monitoring of Rice Arthropods in Bogura Region**	
1.1	Insect pests and natural enemies in light trap.	The abundance of YSB and GLH was observed through out the year in Pennsylvanian light trap. The highest number of YSB was observed during the month of April and October. BPH and WBPH incidence were observed from Mid-October to November and again in April to June 2020. GLH was

SI. No.	Programme area/ Project (Duration)	Expected output
		observed at the vegetative stage of rice during aus, aman and boro seasons.
1.2	Survey of rice insect pests in selected AEZ's of Bogura region.	Survey using sweep net (20CS) in rice field showed that YSB incidence was highest in Sirajganj compared to other three districts. However, GLH incidence was higher in Joypurhat and Bogura districts. Among the NE, spider incidence was observed in all the survey locations.
1.3	Survey of gallmidge incidence in selected areas.	Survey was done in project sites. Data are compiling now and will be analyzed soon.
2	Bio-ecology of rice insect pest and natural enemy	
2.1	Identification of gallmidge biotype(s) in Bangladesh.	Phenotypic study was not done due to the unavailability of differential materials/germplasm.
2.2	Validation of gallmidge resistant sources (germplasm /landraces) in endemic areas.	Validation experiments of GM resistant sources /donors were conducted in T. Aman /2019 season at GM endemic areas especially in five project sites {Gazipur (Kapasia), Natore (Sadar), Dinajpur (Sadar/ Kaharul), Habiganj (Chunarughat) and Cox's Bazar (Sadar)}. Unfortunately, the susceptible checks (BRRI dhan49) in all the experimental sites were free from GM incidence except Habiganj (Chunarughat) and Cox's Bazar (Sadar). The infestation pattern of GM was below the ETL level in Habiganj (Chunarughat) and Cox's Bazar (Sadar). So, field screening will be done again in T. aman/2020 season.
3	Biological control of rice insect pests	
3.1	Study on entomogenous fungi to control BPH.	A quick growing entomopathogenic fungus *Metarhizium anisopliae* (MA), rearing and multiplication technique is developed on plain boiled rice (at 30^{0C}). Fungal Conidia or mycelia have capacity to infest live BPH, WBPH and SBPH at field condition. However, It's effect on environment need to be studied.
4	**Crop Loss Assessment**	
4.1	Relationship between gall midge damage and yield loss.	One per cent damage of GM to BRRI dhan52 and BRRI dhan49 can reduced yield 1.08% and 1.02%, respectively.
5	Evaluation of botanicals against rice insect pests	
5.1	Effect of selected botanicals (mahogany, neem and local plants) on major rice pests.	Seed extracts of mahagany and neem storage for long time (9 months) were used to control SB in rice field, The extract lose it's efficacy and did not show any mortality compared to control treatment.
6	Host plant resistance	
6.1	Screening of rice germplasm, advance line and F_2 materials against rice gallmidge	A total of 228 rice germplasm/ varieties were screened against gallmidge during the reporting period. The BRRI released varieties, different germplasm, differential sets, Alart (1-4), RYT, PQR, SV (Inger) and Rangpur RS materials were screened against rice gallmidge. Among the PQR tested materials, Shampakatari (shingra, Natore) was recorded as resistant (0% OS) against GM. Only the line BR8693-17-6-2-

SI. No.	Programme area/ Project (Duration)	Expected output
		1 out of 19 rice germplasm, was found resistant against GM during the study period. Besides, differential materials were tested against GM, and found that four differentials {Mudu kiriyal, Sudurvi305, Warrangal culture1263, RD4 (Bkn6805-22-13)} showed resistant reaction; and Horanamawee (IRRI) and RD9 (IRRI) showed moderately resistant reaction to the tested GM population. Among the BRRI released varieties, none showed resistant or morderately resistant reaction against gallmidge except BRRI dhan33, which is the only resistant source used as resistant check in gallmidge screening
6.2	Studies on the genetic mechanism of rice blast and gallmidge resistance in BRRI dhan33	A total of 625 markers were surveyed for polymorphism studies between BRRI dhan33 and US2 (a universal blast and galmidge susceptible variety). Among **625** markers, 184 showed polymorphic reaction. The phenotyping and also genotyping of 300 BC_1F_2 family lines were done. Out of 300 BC_1F_2, DNA was extracted from 287 lines using CTAB method. Side by side, blast and gallmidge screening with the selected lines are advancing. Selected polymorphic marker will be procured soon.
7	Integrated management of regional problems	
7.1	Performance of different organic manure for the amendment of char land soil.	Application of vermi-compost @ 1 t/ha in char land soil gave higher yield (6.98 t/ha) of BRRI dhan89 among the four treatments. BRRI recommended dose (Urea-TSP-MOP-GYP @ 217-75-80-62 kg/ha) gave 2nd highest yield followed by the cowdung (@ 4 t/ha) and control (no fertilizer) treatment. For more confirmation, further study is needed.
7.2	Collection and characterization of BPH populations from endemic areas.	Rearing facilities are not yet developed at BRRI Regional Station, Sirajganj. So, we have to wait for the insectary.
7.3	Improving soil water availability for crop production in char land by amendment.	In boro season, Vermi-compost (@ 2.5 t/ha) treated plot gave higher plant height, higher effective panicle as well as higher yield (8.42 t/ha) compared to other treatments. In addition, Top soil (0-10 cm) mixed separately with vermi-compost (@ 2.5 t/ha), 50% clay soil and Cowdung (@5t/ha) gave almost similar per centage of yield advantage over control treatment. However, top soil mixed with Biochar (@ 5 t/ha) showed lowest yield advantage (8.33%) over control.
7.4	Effect of biochar on rice yield and soil health on problem soils	Application of biochar derived from chita dhan showed positive impact on growth and yield of rice. Among the two rates of biochar, application of biochar @ 4 t ha^{-1} with recommended fertilizer dose performed best in increasing the yield of BRRI dhan87 and BRRI dhan89 in T. Aman and Boro seasons, respectively. Although, the effect of Biochar was not significant in Boro season it might have residual effect on the next crop. Therefore, further investigations are required to get more clear messages on biochar.

SI. No.	Programme area/ Project (Duration)	Expected output
8	Vertebrate pest management	
8.1	Survey, collection, identification and documentation of owl species in different areas of Bangladesh.	As of now, three species of owl were collected and brought to the owl aviary to identify at species level for proper documentation. The collected sample(s) are now reared in small aviary at BRRI, Gazipur for further study.
8.2	Study on barn owl biology and their mass rearing both in nature and in confine situation.	Study on barn owl biology and their mass rearing activities depend on the establishment of owl aviary and rat breeding ground. It will be established using NATP2 project fund.
8.3	Placement and observation of owl watching tower (OWT) and nest boxes in rice field	Field evaluations are continued using owl watching tower (OWT) except the nest box. Plots having OWT at 15m interval had 10-15% less active burrow within 50 diameter area of OWT compared to untreated control plots. However, newly developed burrows became inactive around 50 dia meter areas indicating that the owl caught rat from the active burrow and the burrow become inactive. In addition, nest box erecting iron pillars are now ready for use. Nest box procuring activities are under process.
8.4	Assessment of rat damage in treated and untreated areas	Assessment of rat damage in treated and untreated areas were done in standing crops during T. Aman/2019 and Boro/2020 season. Data are now compiling.
8.5	Test of efficacy and modification of different rat management options.	Four different types of eco-friendly rat capture devices are evaluating in rice field ecosystem. Rat capture device need to be modified and fine-tuned for greater trap success.
9.0	Agrometeorology and Crop Modeling	
9.1	Time of Planting experiment for DSSAT	Optimum planting of BRRI released HYV (BR26, BRRI dhan48 and BRRI dhan82) gave significantly higher yield than the late planting one. However, seeding on 10th May did not gave any yield due to high temperature at flowering stage.
9.2	Fertilizer experiment for DSSAT	Five different doses of Urea fertilizer were applied in char land soil keeping other fertilizers as recommended dose to find out the optimum dose of urea. Sixty kg N/ha gave higher yield compared to other dose of N-fertilizer.
9.3	Irrigation experiment for DSSAT	Irrigation application when water level goes 15 cm below groung surface gave satisfactory yield compared to Irrigation at 30 cm depth and rainfed condition.
9.4	Integrated weather forecasting and rice advisory system (IWFRAS) for sustainable productivity in Bangladesh	Rice agro-advisories for the management of rice insect pests for Aus, Aman and boro seasons were prepared based on weekly weather forecast and were submitted to the focal point of IWFRAS regularly to be used by different users for better crop yield.