CONTENTS

Topics			Page
Scientists of BWMRI			**vii**
Scientific Staffs of BWMRI			**viii**
General instructions for conducting wheat experiments			**ix**
Breeding methodology of BWMRI			**xi**
PROJECT 1: WHEAT VARIETY DEVELOPMENT			1
A. NATIONAL AND INTERNATIONAL PROGRAMME			1
Sub-Project 1.1	**Development of High Yield Potential Variety**		1
	1.1.1	Hybridization	2
	1.1.2	Confirmation of single and top crosses	3
	1.1.3	Selection in F_2 to F_6 generations	4
	1.1.4	Estimation of genetic distance of bread wheat parental stock	6
	1.1.5	Germplasm Maintenance	7
	1.1.6	Development of wheat core collection from national and international screening nurseries and yield trials	8
	1.1.7	Bangladesh Wheat Screening Nursery-1 (BWSN-1)	9
	1.1.8	Bangladesh Wheat Screening Nursery-2 (BWSN-2)	10
	1.1.9	Preliminary Yield Trial (PYT)	11
	1.1.10	Advance Yield Trial (AYT)	12
	1.1.11	Candidate Variety Demonstration (CVD)	13
	1.1.12	Distinctness, uniformity and stability (DUS) Test	14
	1.1.13	Adaptive trial with advance wheat lines at MLT sites	15
	1.1.14	On-station demonstration (OSD)	17
	1.1.15	Genetic gain of wheat varieties in Bangladesh	17
Sub-Project 1.2	**Development of Heat Tolerant Wheat Genotypes**		18
	1.2.1	8th Early heat tolerance wheat screening nursery (7th EHTWSN)	19
	1.2.2.	Heat Tolerant Wheat Yield Trial (HTWYT)	20
Sub-Project 1.3	**Development of Drought Tolerant Wheat Genotypes**		21
	1.3.1	8th Drought Tolerant Wheat Yield Trial (7thDTWYT)	21
	1.3.2	Evaluation of drought tolerant advanced lines in Barind area	22
Sub-Project 1.4	**Molecular and Double Haploid Breeding**		23
	1.4.1	Production of wheat double haploids	23
	1.4.2	Molecular characterization of wheat advance lines using SSR markers	23
	1.4.3	Molecular screening of blast resistance wheat genotypes using 2NS markers	25
	1.4.4	Screening of superior 20 wheat genotypes for their potentiality towards heat, salinity and drought using published molecular markers	26
	1.4.5	Selection of blast resistant individuals from different filial generations through MAS	27
	1.4.6	Improving drought tolerance using marker-assisted recurrent selection	28
Sub-Project 1.5	**Development of Blast Resistant/Tolerant Variety**		29
	1.5.1	Development of blast resistant/tolerant variety	29
	1.5.2	Confirmation and evaluation of 2NS X Non 2NS and 2NS X 2NS F_1 in Jashore	30
	1.5.3	Accelerating wheat breeding program through cutting-edge genomics and phenomics technologies	31
	1.5.4	Multilocation testing of selected wheat lines from genomic selection trials	32

	1.5.5	Improving wheat blast resistance and/or tolerance using marker-assisted recurrent selection	33
	1.5.6	Double haploid in wheat blast breeding	34
	1.5.7	Evaluation of selected blast resistant line in PPP	35
Sub-project 1.6	**Collaborative Studies with International Organizations**		36
	1.6.1	Elite Spring Wheat Yield Trial (41th ESWYT)	36
	1.6.2	International Bread Wheat Screening Nursery (53rd IBWSN)	36
	1.6.3	High Temperature Wheat Yield Trial (19th HTWYT)	36
	1.6.4	Semi-arid Wheat Yield Trial (28th SAWYT)	36
	1.6.5	Semi-arid Wheat Screening Nursery (38thSAWSN)	36
	1.6.6	Wheat Yield Consortium Yield Trial (9th WYCYT)	36
	1.6.7	Collaborative Wheat Yield Trial (3rd CWYT)	36
	1.6.8	Stress Adaptive Traits yield Nursery (10th SATYN)	36
	1.6.9	Harvest Plus Yield Trial (11th HPYT)	36
	1.6.10	Harvest Plus South Asia Nursery (12th HPAN)	36
	1.6.11	20th South Asian Bread Wheat Genomic Prediction Yield Trial (20th SABWGPYT)	36
	1.6.12	28th (High Rainfall Wheat Yield Trial (28th HRWYT)	36
	1.6.13	International Durum Yield Nursery (52 IDYN)	36
Sub-project 1.7	**Bio-fortification in Wheat**		37
	1.7.1	7th Zinc-enrich wheat yield trial (7thZnWYT)	37
Sub-project 1.8	**Participatory Variety Selection (PVS)**		38
	1.8.1	PVS: Mother and baby trials and informal seed dissemination	38
Sub-project 1.9	**Development of Durum and Triticale Variety**		40
	1.9.1	Durum Yield Trial (DYT)	40
	1.9.2	Triticale Yield Trial (TYT)	40
Sub-project 1.10	**Variety Maintenance and Breeder Seed Production**		41
	1.10.1	Maintenance of First and Second Year Lines of Recommended Varieties	41
	1.10.2	Breeder seed production of recommended wheat varieties	42
	1.10.3	Multiplication of pre-released wheat varieties	43
	1.10.4	Seed increase of recommended varieties and the lines included in the nurseries and trials of wheat, triticale and durum	43
B. SPECIAL PROGRAMME			45
Sub-project 1.11	Development of Salinity Tolerant Variety		45
	1.11.1	Wheat variety/line screening in saline area	45
	1.11.2	Screening of wheat genotypes in the saline soil of Bangladesh	46
Sub-Project 1.12	**Development of stress tolerant variety**		47
	1.12.1	Molecular characterization of bread wheat (*Triticum aestivum* L.) germplasm for drought tolerance using SSR markers	47
	1.12.2	Screening of advanced wheat genotype under hawar area in Habigang district	48
	1.12.3	Identifying of genotypic potentiality of wheat and maize in non-traditional daily use	49

	1.12.4	Analysis of various components of recent released varieties and advanced lines of wheat	50
PROJECT 2: MAIZE IMPROVEMENT PROGRAM 2020-2021			52
Sub-project 2.1:	**Germplasm Collection, Characterization and Maintenance**		52
	2.1.1	Maintenance and characterization of locally developed inbred lines of maize (8 sets)	52
	2.1.2	Maintenance of exotic inbred lines of maize (2 Sets)	53
Sub-project 2.2:	**Development of source population and inbred lines**		
	2.2.1	Development of base population in maize	53
	2.2.2	Advancing S_1 to S_2 generation of field corn	54
	2.2.3	Advancing S_3 to S_4 generation of waxy maize (2 sets)	55
	2.2.4	Advancing S_4 to S_5 generation of field corn	56
	2.2.5	Advancing S_5 to S_6 generation of sweet corn (2 Sets)	57
	2.2.6	Advancing S_6 to S_7 generation of field corn and baby corn (3 sets)	57
Sub-project 2.3:	**Evaluation of inbred lines**		
	2.3.1	Genetic diversity of locally developed inbred lines	58
	2.3.2	Evaluation of inbred lines of field corn through line × tester method (3 Sets)	59
Sub-project 2.4:	**Evaluation of single cross hybrids**		
	2.4.1	Study on combining ability and heterosis in field corn	60
	2.4.2	Evaluation of selected single cross hybrids of field corn	61
	2.4.3	Evaluation of locally developed promising pro vitamin A enriched hybrids	62
	2.4.4	Evaluation of promising hybrids of field corn hybrids at different agro-ecological regions (3 sets)	62
	2.4.5	Comparative yield trial of imported & local maize hybrids	63
Sub-project 2.5:	**Stress Breeding - Abiotic stress tolerant variety development**		
	2.5.1	Phenotyping of the HTMA hybrids during rabi season (5 Sets)	64
	2.5.2	Evaluation of selected promising maize hybrids for saline areas (2 sets)	65
	2.5.3	Evaluation of promising maize hybrids for haor areas	66
	2.5.4	Phenotyping of the HTMA hybrids under heat stress(9 Sets)	67
	2.5.5	Phenotyping of the HTMA hybrids under optimal temperature(5 Sets)	68
Sub-project 2.6:	**Production of New Hybrids**		
	2.6.1	Production of single cross fall army worm resistant hybrids through diallel mating	69
	2.6.2	Seed production of promising maize hybrids of field corn and popcorn (7 Sets)	69
	2.6.3	Seed Production of single cross maize hybrids though Line×Tester method in isolation (2 Sets)	70
Sub-project 2.7:	**Maintenance and seed increase of parental/inbred lines**		
	2.7.1	Maintenance and seed increase of the parental lines of different released maize hybrids	71
	2.7.2	Seed production of the parental lines of different released maize hybrids (11 sets)	72
	2.7.3	Seed production of the parental lines of promising maize hybrid (3 sets)	73
Sub-project 2.8:	**Seed Production of different released hybrids**		74
	2.8.1	Seed production of BARI/WMRI hybrid maize (7 Sets)	74
	2.8.2	Seed production of promising maize hybrid	75
Sub-project 2.9:	**Maintenance and seed production of Open-pollinated varieties**		76

	2.9.1	Maintenance and seed production of composite maize varieties (2 Sets)	76
Sub-project 2.10:	**Collaborative program**		77
	2.10.1	On-farm evaluation of HTMA hybrids with popular checks (Selections from 19 S CRTs) (8 Sets)	77
	2.10.2	On-farm evaluation of HTMA hybrids with popular hybrids (Selections from 19 K CRTs) (8 Sets)	77
	2.10.3	On-farm evaluation of HTMA hybrids with popular hybrids (2 Sets)	78
	2.10.4	On farm CIMMYT-Asia Regional Trials (CRT) based on selections from Stage III of Spring 2020 (6 Sets)	79
PROJECT 3: CROP & SOIL MANAGEMENT			
SUB-PROJECT 3.1: CROP MANAGEMENT			80
Sub-Sub-Project 3.1.1: RESOURCE CONSERVATION			80
	3.1.1.1	Long-term bed planting trial for improving crop and soil productivity in rice-wheat-mungbean cropping pattern	80
	3.1.1.2	Weed management of Wheat-Mungbean-Rice cropping pattern in CA at drought prone Rajshahi region	81
	3.1.1.3	Effect of fertilizer doses with biochar on soil fertility and crop productivity of wheat-maize-rice cropping pattern in drought prone area	83
	3.1.1.4	Integrated fertilizer management on soil fertility and productivity of Wheat -T. Aus–T. Aman cropping pattern	85
Sub-Sub-Project 3.1.2	**WHEAT-MAIZE SYSTEM**		86
	3.1.2.1	Evaluation of different herbicides to control weeds in maize field	86
	3.1.2.2	Development of Hertilizer Recommendation for Hybrid Maize in Kharif Season	87
	3.1.2.3	Response of Maize–Legume Intercropping as Push–Pull Technique to Control Fall Armyworm	88
Sub-Sub-Project 3.1.3	**PHYSIOLOGICAL STUDIES**		89
	3.1.3.1	Study the performance of some selected wheat genotypes in southern Bangladesh	89
	3.1.3.2	Response of newly evolved wheat varieties to sowing dates	90
	3.1.3.3	Screening of wheat genotypes against salinity at seedling stage	93
	3.1.3.4	Determination of Seed Rate of Wheat for Late Sown Condition	94
SUB-PROJECT 3.2	**SOIL MANAGEMENT**		95
	3.2.1	Effect of different doses of vermicompost in combination with chemical fertilizers in a Wheat-Maize-T. Aman rice cropping pattern	95
PROJECT 4: PEST MANAGEMENT			
Sub-project 4.1	**Disease Management**		97
	4.1.1	Evaluation of wheat germplasm against Bipolaris leaf blight under field condition	97
	4.1.2	Evaluation of wheat genotypes for resistance to Bipolaris leaf blight under inoculated condition	98
	4.1.3	Evaluation of wheat genotypes for resistance to leaf rust under inoculated condition	99

	4.1.4	Efficacy of fungicides in controlling Bipolaris leaf blight of wheat	100
	4.1.5	Efficacy of fungicides in controlling leaf rust of wheat	101
	4.1.6	Adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight	102
	4.1.7	Monitoring and evaluation in international wheat disease nurseries	103
	4.1.8	Surveillance of rusts and blast of wheat in Bangladesh	104
	4.1.9	Evaluation of wheat germplasm against wheat blast under field/inoculated condition	105
	4.1.10	Evaluation of elite wheat lines for resistance to blast under inoculated condition	106
	4.1.11	Efficacy of foliar fungicides in controlling wheat blast	107
	4.1.12	Determining status of seed-borne fungi including *Magnaporthe oryzae* pathotype *triticum* causing wheat blast	108
	4.1.13	Molecular detection of wheat blast pathogen *Magnaporthe oryzae* pathotype *triticum* (MoT) collected from different locations of Bangladesh using MoT3 assay and nucleotide sequencing	109
	4.1.14	Wheat blast: Precision Phenotyping Platform	110
	4.1.15	Surveillance and monitoring of diseases of Maize in Bangladesh	111
	4.1.16	Efficacy of fungicides in controlling leaf blight of maize	111
Sub Project 4.2	**Insect management**		113
Sub-sub-project 4.2.1: Wheat Insects			113
	4.2.1.1	Survey of insect pests and natural enemies in wheat and determination of damage potential due to insect pests	113
	4.2.1.2	Yield loss assessment of wheat due to the aphid infestation	
Sub-sub-project 4.2.2: Maize Insects			114
	4.2.2.1	Monitoring and scouting of insect pests on maize and their natural enemies	114
	4.2.2.2	Development of management package(s) to control FAW on maize	115
	4.2.2.3	Effect of seed treatment with Cyantraniliprole (Fortenza 60FS) to control Fall Armyworm, *S. frugiperda* (Lepidoptera: Noctuidae) on maize	116
	4.2.2.4	Assessment of the seasonal abundance and infestation intensity of FAW *S. frugiperda* (Lepidoptera: Noctuidae) on maize	117
	4.2.2.5	Agro-ecological approaches of FAW *S. frugiperda* (Lepidoptera: Noctuidae) management on maize	118

PROJECT 5: AGRICULTURAL ENGINEERING			120
Project 5	**Agricultural Engineering**		120
	5.1.	Battery operated low cost maize planter cum weeder	120
	5.2.	Improvement of two wheel tractoroperated strip till planter for upland crops	121
	5.3	Development of tractor (4WT) operated multi crop seeder	122
PROJECT 6: TECHNOLOGY VALIDATION AND TRANSFER			123
SUB-PROJECT 6.1	**DEMONSTRATION**		124
Expt. 6.1.1	Variety demonstration		124
SUB-PROJECT 6.2	**TRAINING, WORKSHOP AND FIELD DAYS**		125
A. NATIONAL PROGRAMME			125
6.2.1	Training to demonstration, PVS, YM farmers and related personnel		125
6.2.2	Training of trainers (TOT) on wheat production and seed preservation		126
6.2.3	Training of trainers (TOT) for DAE, BADC and NGO personnel on wheat production and seed preservation		127
6.2.4	Five days training for young scientists on research planning, execution, data recording, analysis and reporting		127
6.2.5	Two days training for SSA/SA/LA		128
6.2.6	Regional Workshop on challenges in wheat production		129
6.2.7	Pre-review, Internal Review and Programme Planning workshops		129
6.2.8	Field days and monitoring of on-farm and on-station research activities		130
BUDGET FOR RESEARCH PROGRAM OF BWMRI 2020-21			131
COMMENTS FROM EXPERTS			132

Scientists of Bangladesh Wheat and Maize Research Institute (BWMRI)

Research Station	Name of the Scientists	Designation	Discipline/Division
BWMRI Dinajpur	1. Dr. Md. Israil Hossain	Director General	Agril. Engineering
	2. Dr. Md. Abu Zaman Sarker	CSO	Agronomy
	3. Dr. Md. Bodruzzaman	CSO	Soil Science
	4. Md. Mostafa Ali Reza	PSO	Pathology
	5. Dr. Md. Alamgir Miah	PSO	Maize Breeding
	6. Dr. Md. Abdul Hakim	SSO	Wheat Breeding
	7. Dr. Md. MahfuzBazzaz	SSO	Agronomy
	8. Dr. Md. Muzahid-E-Rahman	SSO	Pathology
	9. Dr. Akbar Hossain	SSO	Agronomy
	10. Dr. Mst. Masuma Akhter	SSO	Agronomy
	11. Kishowar-E-Mustarin	SSO	Pathology
	12. Dr. MM Rahman Shah	SSO	Entomology
	13. Dr. Md. Zaherul Islam	SSO	Wheat Breeding (Deputed to Japan)
	14. Dr. MSN Mandal	SO	Wheat Breeding
	15. Dr. MR Kabir	SO	Wheat Breeding
	16. Dr. MA Alam	SO	Wheat Breeding
	17. Md. Monwar Hossain	SO	Wheat Breeding
	18. Dr. Md. NurAlam	SO	Wheat Breeding
	19. Asgar Ahmed	SO	Maize Breeding
	20. Md. Farhad	SO	Wheat Breeding (Deputed to India)
	21. Sariful bin Ekram	SO	Agril. Engineering
	22. Krishna Kanta Roy	SO	Pathology
	23. Rokshana Begum	RA	CRP/ACIAR WB project
	24. Tonusree Roy	RA	CRP/ACIAR WB project
	25. Farjana Bashar	RA	KGF WB project
BWMRI Jessore	1 Rabiul Islam	SSO	Wheat Breeding
	2. Md. Babul Anower	SO	Pathology
BWMRI Jamalpur	1 Dr. Md.Mosharraf Hossain	PSO	Pathology
	2 Md. Mokhlesur Rahman	SSO	Wheat Breeding
BWMRI Rajshahi	1 Dr. Md. Illias Hossain	PSO (In-charge)	Agronomy
	2 Dr. Md. Abdullah-Al-Mamun	SSO	Wheat Breeding
	3 Dr. Kh. Habibul Alam	SSO	Pathology
	4 Dr. Abul Awlad Khan	SO	Wheat Breeding
	5 Md. Mahbubur Rahman	SO	Wheat Breeding
	6 S M Mahbubul Alam	SO	Soil Science
	7 Md. Zakir Hossain	SO	Agril. Engineering
	8 Mrs. Yasmin Abida	SO	Breeding
BWMRI Joydebpur	1 Dr. GolamFaruq	PSO (In-charge)	Wheat Breeding
	2 Md. Mahbubur Rahman	SSO	Wheat Breeding
	3 Dr. Md. Mustafa Khan	SO	Agronomy
	4 Md.Mahmudul Hasan	SO	Wheat Breeding
	8 Md.Farhad Amin	SO	Wheat Breeding
	10 Mohammad Ahsan Ali	FS	Agronomy

Scientific Staff of Bangladesh Wheat and Maize Research Institute (BWMRI)

Research Station	Name of the Scientific staff	Designation
BWMRI Dinajpur	Md. Moniruzzaman	Senior Scientific Assistant
	Md. Kamal Mahamud Sharif	Scientific Assistant
	Md. Badsha Mia	Scientific Assistant
	Md. Latifur Rahman	Scientific Assistant
	Md. Zillur Rahman	Scientific Assistant
	Md. Arifur Rahman Rubel	Scientific Assistant
	Md. Soriful Islam	Scientific Assistant
	Md. Salamun	Research Assistant
	Md. Rokunuzzaman Sarker	Research Assistant
	Faruk Hossain	Research Assistant
	Md. Abdul Awal	Laboratory Attendant
	Sopon Kumer Ray	Laboratory Attendant
	Sukamol Chandro Ray	Laboratory Attendant
BWMRI Jessore	Md. Kamal Hossain	Scientific Assistant
	Swapon Roy	Scientific Assistant
	Md. Alamin	Research Assistant
	Md. Monjurul Islam	Research Assistant
	MrsAnawara Begum	Research Assistant
	Mrs. Nulufar Yasmin	Research Assistant
	Md. Mamunur Rashid	Laboratory Attendant
	Md. Shamser Ali	Laboratory Attendant
BWMRI Jamalpur	Sayeda Akhter Sunny	Scientific Assistant
	Md. Anowar Hossain	Scientific Assistant
BWMRI Rajshahi	Md. Mozahar Ali Mollah	Senior Scientific Assistant
	Sheikh Md. Fazlur Rahman	Senior Scientific Assistant
BWMRI Joydebpur	Mst Parul Begum	Scientific Assistant

GENERAL INSTRUCTIONS FOR CONDUCTING WHEAT EXPERIMENTS

Fertilizer Rates:

All irrigated and non-irrigated experiments will be fertilized at the rate of 100:26.50:20:5:1 kg/ha of N P K S Zn B and 60:26.50:20:5:1 kg/ha N P K S Zn B, respectively, except in some low fertility trials.

Seed Rates:

All irrigated and non- irrigated experiments will be planted with 120 kg ha^{-1} (having 80% or above germination).

Seed Treatment:

Experimental seeds will be treated with Provax-200 @ 3g kg^{-1} seed at the time of preparing sets.

Weed Control:

Weed should be control at 25-30 DAS through one hand weeding or herbicide (Affinity@ 25 g powder with 10 liters water for 5 decimal areas). For herbicide, spray should be uniform to protect plant injury.

Seeding Time:

The experiments earmarked for optimum (timely sown) and late seeding (late sown) will be followed as November 20-30 and December 25-30, respectively.

Irrigations:

Normally, for irrigated experiments, there will be three irritations at CRI, heading and grain filling stage. One or two extra irritations may be required in sandy soil.

Inoculations:

All segregating populations, screening nurseries and trials will be surrounded by border rows with mixture of varieties susceptible to leaf rust and leaf blight diseases. These border rows will be inoculated by leaf rust/*Bipolaris* spores for creating artificial infection once in a week starting from three weeks after sowing until primary infection is observed.

DATA RECORDING:

Observations needed for wheat breeding experiments have been described hereunder. Data on all the parameters are not required for all the experiments.

Plants/m^2: Plant count after germination at Zadok's GS 14 will determine the seedling and crop establishment. Plant count should be made for number of plants in 1m from each of 5 middle rows in case of yield trials (= plants/m^2) and in 0.33 m from each of 3 rows in case of screening nurseries (plants x 5 = plants /m^2). Counting should be made diagonally of the plot.

Ground cover: Estimate visually the percentage of the soil that is covered by green biomass in each plot, when viewing plots down the rows at an angle of 45 ^{0} to the vertical. Percent ground cover is generally practiced at Zadok's Growth Stage 15 (5 leaf stage) and Growth Stage 65 (at 50% anthesis).

Days to 50% flag leaf emergence (Zadok's 35): Number of days when 50% of the flag leaf ligule is just visible.

Days to heading: Number of days from sowing to the day when base of the 50% of the spikes just come out from the flag leaf sheath.

Days to anthesis: Number of days from sowing to when 50% of the spikes have extruded some anther (Zadok's GS 65).

Visual sterility: Percent of florets remained open for several days after anthesis (whole plot basis). A visual estimate records as 0, 5, 10, 20, 30, 40, 50, 60, 70, 80, and maximum 90%. Plots with no sterility will be 0%.

Bipolaris leaf blight: Leaf blight scoring should be done thrice (unless otherwise mention), at Zadok's growth stage 69-71, 73-75 and 77-83 following double-digit (00-99) scale (CIMMYT pictorial guide).

Leaf rust: Leaf rust scoring should be done thrice (unless otherwise mention), at Zadok's growth stage 69-71, 73-75 and 77-83 following modified Cobb's scale (CIMMYT pictorial guide).

Lodging score: Lodging score will be taken at physiological maturity in percentage on whole plot basis (% plants lodged).

Plant height: Grasp a clump of spikes and measure the distance in cm from the ground to the top most representative spikes (excluding the awn).

Days to maturity: The number of days from seeding to physiological maturity on whole plot basis (Loss of green color from 50% of the ear-bearing culms of a plot).

Spikes/m^2: Count the number of developed and underdeveloped spikes in 5 samples of 1m row in case of yield trials (= spikes/m^2) and 3 samples of 0.33m row in case of screening nurseries (No. of spikes x 5 = spikes/m^2). Counting should be done diagonally at physiological maturity to avoid damage of plants due to walking inside plot.

Spikelets/spike: Mean spikelets of the 10 randomly selected spikes. In general, two underdeveloped basal spikelets and one terminal spikelet of each spike are to be excluded.

Grains/spike: After counting the spikelets of the 10 randomly selected spikes, thresh all 10 spikes and count all the grains of those spikes and divide by ten.

Grain set: Fertility of the spike will be measured by grain set per spikelet. To isolate a sterile floret from pollination by air borne pollens, 10 spikes will be bagged using emasculation bag just after heading and before anthesis to avoid out crossing.

$$\text{Grain set} = \frac{\text{Mean grains/spike}}{\text{Mean spikelets/spike}}$$

Biomass: Cut the plants at ground level at maturity. Dry the plants in the sun for 4 to 5 days. Take the total weight in grams/kilograms of the plants before threshing and record the dry seed weight after threshing to calculate harvest index. In case of green samples oven drying is required.

Harvest Index: Calculate from total biomass and grain yield as follows:

$$\text{Harvest index (\%)} = \frac{\text{Weight of grains}}{\text{Total weight (Biomass)}} \text{ X } 100$$

Yield Adjustment at Standard Moisture: Adjusted yield at expected moisture percent is

$$Yadj = Y_{AC} \text{ X } \frac{(100 - M_{AC})}{(100 - M_{ST})}$$

Where,Yadj= Adjusted yield,Y_{AC}= Yield at actual moisture percent, M_{AC}= Actual moisture percent; M_{ST} = Standard moisture percent

BREEDING METHODOLOGY OF BWMRI

Year	Location	Filial Generation	Selection System
1st year	Din, Jes, Jam, Raj and Joy	Hybridization	Four hundred crosses (200 single, 150 Top and 50 limited back) crosses will be made for major objectives in all locations
2nd year	Din, Jes, Jam, Raj and Joy	F_1	All types of F_1s are to be grown in 2.5m 2 rows in respective stations. All types of F_1s will be space seeded. At least 50 selected spikes from single cross progeny will be harvested in bulk With some negative selection at least 30 spikes from selected plants of top and back cross progeny will be harvested in bulk (**Selected bulk**).
3rd year	Din, Jes, Jam, Raj and Joy	F_2	F_2 is to be space planted in 10m 6 row plots in respective stations. Spikes from around 50 selected plants of selected population will be harvested in bulk (**Selected bulk**). Keep remaining seeds after seeding as remnant.
4th year	Din, Jes, Jam and Joy	F_3	F_3 is to be solid seeded in 5 m 6 rows. Spikes from 30 selected plants of selected family will be harvested in bulk (**Selected bulk**).
5th year	Din, Jes, Jam and Joy	F_4	F_4 is to be solid seeded in 5m 6 row plots at respective stations. Spikes from 30 selected plants of selected family will be harvested in bulk (**Selected bulk**).
6th year	Din, Jes, Jam and Joy	F_5	F_5 is to be space planted in 10m 6 row plots and grow crop with high management (OM + 120kg N/ha). Around 10 plants selected, harvested and thresh individually (around 200 seeds/plant will be obtained) and preserve separately for F_6 (**Pedigree method**).
7th year	Din, Jes, Jam and Joy	F_6	F_6 is to be grown in 2.5m long 4 row plots under high management (OM + 120kg N/ha). Bulk selected whole plots; around 800g seeds will be obtained which will be enough for screening in BWSN next year. All stations will send their seeds to Dinajpur for preparing BWSN sets.
8th year	On-station Multi Loc.	BWSN (F7)	Multi location(3 sites) yield and adaptability testing
9th year	On-station Multi Loc.	PYT (F_8)	Multi location (4 sites) yield and adaptability testing
10th year	On-station Multi Loc.	AYT (F_9)	Multi location yield and adaptability testing + DUS testing
11th year	On-farm and On-station Multi Loc.	OFT (F_{10})	Multi location yield, adaptability and DUS testing at on-station and farmers' field for evaluation by technical committee of SCA/NSB

VARIETY RELEASE

PROGRAMME: WHEAT AND MAIZE IMPROVEMENT

Wheat is the second important cereal crop next to rice in Bangladesh. Wheat has some advantages in its cultivation compared to Boro rice and other winter crops i.e. less water requirement, echo-friendly, high nutritional value, diversified use, etc. Consumption growth rate of wheat is increasing at the rate of 15% in recent years due to rapid changing of dietary habit and diversified use in Bangladesh. Present wheat production is about 1.2 million ton against the annual demand of about 7.0 million ton. The wheat productivity has been increasing in recent years due to adoption of new varieties and recommended production technologies by the farmers and reached to 3.64 t/ha in 2019-20. To meet up the demand of wheat for the growing population of the country, the present national yield level needs to be further raised and subsequently be sustained in the rice-wheat system. And to address these targets full compression has given on biotic (BpLB, Rust and Blast) and abiotic (Salinity, heat and drought) stress breeding to develop potential wheat varieties for expanding both vertical and horizontal wheat development to boost up national wheat production for increased food security in Bangladesh. The current yield level can be scaled up by eliminating production problems encountered by the farmers. Emphasis has been given to diversify high yielding heat tolerant and disease resistant varieties at farmers' level. A special targeted location screening program on Salinity heat and drought has designed from the upcoming season 2020-21 which will be set up the Southern region, Rajshahi and Sylhet region. Where F_2 to F_5 generations will be screened. Development of bio-fortified wheat variety enriched with Zn and Fe content has also been due emphasized in the programme. Majority of wheat in Bangladesh is sown after rice and many production problems such as late seeding, formation of plough pan due to puddling in transplanted rice, water logging, low organic matter content, boron deficiency and soil acidity, foliar diseases, etc. which affect wheat production. Current wheat improvement program is undertaken to achieve the national goal by developing high yielding varieties for specific problem areas, appropriate crop and soil management strategies including efficient use of water and other inputs. Introduction and adoption of appropriate machinery like seeder, reaper and thresher at farm level is also emphasized. Priority has also been given to technology transfer activities through variety and block demonstrations, farmers' training, workshops, publications of booklets, folders etc.

A. NATIONAL AND INTERNATIONAL WHEAT PROGRAMME

PROJECT 1: WHEAT VARIETY DEVELOPMENT

The project is aimed to develop high yield potential heat and disease resistant/tolerant varieties for different growing environments. Research in this area is based on two major growing environments: irrigated timely sown (ITS-November 20-25) and irrigated late sown (ILS-December 20-25) conditions. Moreover, research programme has also been taken to develop varieties for specific problem areas like sterility, soil salinity, char areas, drought (Barind area). Participatory variety selection (PVS) at farmers' field is another approach where BWMRI has given research priority. Limited research work on Durum and Triticale is also duly undertaken. Overall modern approach of variety development programme has been undertaken to develop appropriate varieties with higher yield potential, wide and specific adaption and resistant to major wheat diseases. Collaborative programs with International and Regional institutions are being maintained through germplasm exchange, training, visits and personal communication.

SUB-PROJECT 1.1: DEVELOPMENT OF HIGH YIELD POTENTIAL VARIETY

Short maturing wheat variety with high yield potential can be well fitted under the rice-wheat cropping system of Bangladesh. About 80% of wheat in our country is grown under rice-wheat rotation. The objective of this sub-project is to develop a variety with high yield potential, terminal heat tolerance, lodging resistance and resistance/tolerance to foliar diseases to make wheat production more profitable. In future, the area under timely sown condition could be expanded by introducing early maturing T. Aman varieties and appropriate planting and harvesting machinery.

Expt 1.1.1: Hybridization

Objective(s)	:	Transfer desirable traits from donor parents to the recipient parent with good agronomic background targeting to develop high yield potential, disease resistant variety with wide adaptation
Rationale	:	Hybridization is highly important for creating genetic variability by recombining/transferring desirable genes from different sources and for selecting expected genotypes. Parental lines included in the hybridization program are from different sources having diversified gene combinations. Crossing between selected parents with desirable traits will generate new combination of genes in segregating filial generations. Thus variability will be created which ultimately help making selection of desirable genotypes.
Methods and methods	:	Diverse parental wheat lines will be grown at 5 different stations. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Ten to fifteen heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top and limited backcrosses. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	:	One hundred and twenty wheat lines arranged in 11 groups (High yielding wheat varieties- 13, Early maturing varieties-11, BpLB tolerant varieties-15, Rust resistant varieties-16, Short height varieties-14, High biomass and high harvest index genotypes-4; Varieties with more grains/spike-5, Varieties with excellent grain filling under late seeding-7, Genotypes with good bread making quality-4,Sterility tolerant genotypes-6, Miscellaneous varieties for further observation-25)
Design	:	Non-replicated
Treatment	:	Genotype
i. Replication	:	Non-replicated
ii. Plot size	:	2.5m long X 3 rows
Planting system/ spacing	:	Space seeding Row to row distance 30 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha^{-1} respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population for evaluation
Investigators	:	MA Hakim, MSN Mandal, MR Kabir, MA Alam, MM Hossain, — Dinajpur G Faruq, MM Rahman, MM Hasan, MF Amin — Joydebpur MM Rahman — Jamalpur
Season	:	Rabi 2020-21

Date of Initiation : 15 November 2020

Date of completion : April 2021

Exp. output/benefit : F_1 plants with desirable gene recombination will be generated

Locations :

Cross	Din	Joy	Jam	Total
Single cross	300 + **50**	250	50	600
Top cross	30	20	10	60
Back cross	20	0	0	20
Total	400	270	60	680

Special Crosses: Additional 50 crosses will be made with the target for developing salinity and drought tolerant early generations

Status : On-going

Estimated cost :

Location	Land area (m^2)	Cost (Tk.)
BWMRI, Dinajpur	3500	150,000/-
RBWMRI, Joydebpur	2500	100,000/-
RARS, Jamalpur	1000	50,000/-
Total	7000	3,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Expt 1.1.2: Confirmation of single and top crosses

Objective(s) :
1. Confirming hybrids derived from crosses between two different parents
2. Generation of F_2 seeds and making top and back crosses utilizing F_1 plants

Rationale : Confirmation in the F_1 hybrids ensures crossing between different parental combinations. Comparing them with their female parents helps to identify if there is any mistake in making crosses and avoid mistake of potential crosses. Confirmed F_1 hybrids are also needed in making top and backcrosses too. Confirmation in F_1 is important step of breeding program which saves time, resource and labor.

Methods and methods : Seven hundred thirty two (601 single, 53 top and 78 limited backcross) F_1s will be evaluated in 2019-20 in respective stations. Two rows of female parent will be grown at the beginning of each set of single cross to compare with the hybrids for confirmation of the crosses. Around 50 spikes from single cross progeny and 30 from top and back cross progeny of selected plants will be harvested in bulk (Selected bulk method) for growing in F_2 generation. Crop management practices will be as per recommendation of BWMRI.

Crop/variety : Wheat

Design : Non replicated

i. **Treatment** : 557 F_1s of wheat

ii. **Replication** : Non replicated

Plot size	**:**	2.5m long X 2 rows
Planting system/ spacing	**:**	Space seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population for evaluation.
Investigators	**:**	MA Hakim, MA Alam, MR Kabir, MSN Mandal, MM Hossain, Dinajpur G. Faruq, MM Rahman, MM Hasan, MF Amin Joydebpur MM Rahman Jamalpur
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	November 2020
Date of completion	**:**	April 2021
Exp. output/benefit	**:**	F_2 seeds with desirable gene recombination
Locations	**:**	Cross Single 527 Top 49 Limited back 20 Total 596
Status	**:**	On-going
Estimated Cost	**:**	Tk.2,00,000/- (Din -100,000/-, Joy-70,000/- and Jamalpur-30,000/-)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt. 1.1.3: Selection in F_2 to F_6 generations

Objective(s)	**:**	1. Ensuring fixation of desirable additive genes in the advancing filial generations 2. Select desirable families/individual plants in each filial generation following selected bulk method 3. Reaching homozygosity/stability after hybridization
Rationale	**:**	Advancing F_2 - F_6 Generations generate a huge number of variable plants. Most of them don't possess desirable traits combinations. Selection in F_2 - F_6 generation is necessary to discard undesirable plants/crosses which don't have potentiality for improvement. Selection of desirable cross and single plant/head from advancing generations reduces the cost saving time, land and labor. It helps in fixation of desirable genes and finding good potential genotypes.
Materials and methods	**:**	**F_2:** 476 F_2 populations derived from single, top and backcrosses will be grown. Desirable families will be selected at the beginning and then individual plants within selected families will be tagged on the basis of

their field performance. About 30-50 spikes from selected plants will be harvested and threshed in bulk. At least 2000 (about 100g) bulked seeds will be collected from the selected individual 50 spikes. Thirty gram bulked seeds (around 600) will be grown next year in F_3. Remaining seeds will be kept as remnant

F_3: 314 selected F_2 populations will be grown as F_3. 30 spikes will be harvested from selected individual plants from the selected populations at each location. Selected spikes will be threshed in bulk. Around 1200 seeds (60g) will be collected from 30 spikes of which 30g (about 600 seeds) will be used for growing F_4 next near.

F_4 : 229 selected F_3 populations will be grown as F_4. Around 30 spikes will be harvested from selected individual plants from the selected populations at each location. Selected spikes will be threshed in bulk. Around 1200 seeds (60g) will be collected from 30 spikes of which 30g (about 600 seeds) will be used for growing F_5 next near.

F_5 : 130F_4 populations will be grown as F_5. Around 10 vigorous plants (10 sisters) with at least 5 fertile spikes/plants will be selected from each selected population. Each plant will be threshed separately and seeds will be preserved individually (Pedigree method). Minimum 200 seeds will be found from each plant which will be used for growing in F_6 next year.

F_6: 804 Single plant populations selected from 103 (Din-18, Joy-13, Jes-28, Raj-26 and Jam-30) F_5 families will be grown as F_6. A total of 500 populations from selected individual plants will be grown. The plant progeny row plots will be selected based on heading, plant height, tillering, disease and sterility tolerance, yielding ability etc. Rouging, if needed, will be done in selected plots only. Selected whole plots will be harvested. About 800g seeds per plot will be collected (considering yield of 4 t/ha) which will be enough for experiments and testing in BWSN in next year.

Crop/variety : F_2 - F_6 populations of wheat

Design : Non replicated

Treatment : Segregating populations of wheat

Replication : Single

Irrigated/rainfed : Irrigated

Fertilizer dose and methods of application : As per BARC recommendations

Plot size :

Generation	F_2	F_3	F_4	F_5	F_6
Plot	20mX6 r	10mX6 r	10mX6 r	20mX6 r	2.5mX4 r

Planting system/ spacing :

Row to row	30cm	20cm	20cm	20cm	20cm
Entry to entry	60cm	60cm	60cm	60cm	60cm
Seeding	Space	Space	Space	Space	Space
Seed rate (kg ha^{-1})	5	10	15	25	30

Data to be recorded : Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population for evaluation.

Investigators : MR Kabir (F2 and F6), MSN Mandal (F3), MA Alam (F4), MM Hossain (F2 to F6) and MA Hakim (F5 and F6). Dinajpur

MM Rahman, MM Hasan, MF Amin, G Faruq	Joydebpur
MM Rahman	Jamalpur
MAA Khan, MM Rahman, MA Al Mamun, Y Abida	Rajshahi
MR Islam,	Jashore

Season : Rabi 2020-21

Date of Initiation : November 2020

Date of completion : April 2021

Exp. Output/Benefit : Desirable genotypes for subsequent generations

Locations : Number of populations (Checks to be included)

Generation	Dinajpur	Joydebpur	Jashore	Jamalpur	Rajshahi
F2	342	113	-	57	-
F3	120	135	-	59	-
F4	37	107	-	64	21
F5	28	31	25	26	20
F6	18	13	16	30	26

Status : On-going

Estimated Cost :

Location	Land area (m^2)	Cost (Tk.)
Dinajpur	15,000	4,50,000/-
Joydebpur	10,000	3,00,000/-
Jashore	5,000	1,50,000/-
Jamalpur	5,000	1,50,000/-
Rajshahi	5,000	1,50,000/-
Total	40,000	12,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt. 1.1.4 Estimation of genetic distance of bread wheat parental stock

Objective(s)

1. To increase accuracy and breeding efficiency
2. To ensure for getting maximum variation in F_2

Rationale : To get good variants from the parental materials it is essential to know the genetic distance of parental parental materials together with the basic genetic information. The selected wheat parental stock are extremely good with attractive agronomic features and specific traits. However, during planning breeding design sometimes parental with minimum genetic distances are crossed and as a result expected materials are not obtained. To minimize these limitations, from the crossing blocks (3 planting dates of the same parental materials) morpho-agromonic data will be collected to estimate Genetic distance together with the necessary genetic parameters

Materials and methods : Around 124 selected potential germplasm in different years will be considered. Each entry will be grown in 2.5 m long 3 rows with row spacing of 20 cm keeping 40 cm space between entries. Crop management practices will be as per recommendation of BWMRI.

Crop/variety	**:**	Bread Wheat Parental stock of BWMRI
Design	**:**	RCBD
Treatment	**:**	Genotype
Replication	**:**	Disperse Replication
Plot size	**:**	2.5 m long × 3 rows
Planting system / spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, 1000-grain weight, physical grain characteristics, grain yield etc.
Investigators	**:**	MA Alam, MM Hossain (Din) and M M Rahman (Joydebpur)
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	On-going
Exp. Output/Benefit	**:**	Preserved genotypes will be used in future for specific purpose.
Locations	**:**	Dinajpur
Status	**:**	Started from the beginning of BWMRI
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt 1.1.5: Germplasm maintenance

Objective(s)		3. Evaluating lines from different national and international sources 4. Maintaining promising lines and preserve for future use
Rationale	**:**	A large number of genotypes are usually included in different nurseries and trials. Most of them could not fulfill the present selection criteria and thus fail to get promotion. Many of these (unselected lines) might have some good potential genes. Throwing all such lines into garbage may result in loss of valuable genetic resources. Evaluation and preservation of these genotypes is highly important for future use.
Materials and methods	**:**	About 400 potential germplasm collected from foreign sources and the materials not selected from different trials but possesses special features will be included in this nursery. Each entry will be grown in 2.5m long 3 rows with row spacing of 20cm keeping 40cm space between entries. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	**:**	Wheat germplasm
Design	**:**	Non replicated
Treatment	**:**	Genotype
Replication	**:**	Non- replicated

Plot size	**:**	2.5m long X 3 rows
Planting system/ spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, 1000-grain weight, physical grain characteristics, grain yield etc.
Investigators	**:**	MM Hossain, MR Kabir and MSN Mandal, MN Alam
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	On-going
Exp. Output/Benefit	**:**	Preserved genotypes will be used in future for specific purpose.
Locations	**:**	Dinajpur
Status	**:**	Started from the beginning of BWMRI
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt 1.1.6	**:**	**Development of wheat core collection from national and international screening nurseries and yield trials**
Objective(s)	**:**	To develop a genetic diversity pool of wheat for accelerating variety development.
Rationale	**:**	Increasing the genetic diversity is the most important priorities of any plant research organizations for improving or developing a crop variety. The BWMRI has a strong collaboration with many of the wheat research organizations including CIMMYT which has the largest wheat gene pool. It also has a strong vision and program to develop wheat varieties for South Asia. Each year BWMRI is creating, receiving, and evaluating hundreds of advanced lines through different screening nurseries and yield trials from many of the international institutes including CIMMYT. Last five years the genomic selection trial of KSU-BWMRI project received about 3000 advanced lines. We are selecting superior lines from national and international nurseries and trials. But in course of time we are losing the selected lines for proper attention, and well management plan. We could not keep them secured as a final cause of having no well-established core collection. Now the BWMRI is an independent institute with good infrastructure. Hence, it is high time to give more emphasis on to establish a wheat core collection with those selected lines.
Materials and methods	**:**	About 400 potential germplasm collected from foreign sources and the materials not selected from different trials but possesses special features will be included in this nursery. Each entry will be grown in 2.5m long 3

rows with row spacing of 20cm keeping 40cm space between entries. Crop management practices will be as per recommendation of BWMRI.

Crop/variety : Sixty advanced wheat lines selected from different screening nurseries and yield trials

Design : Alpha lattice

Treatment : 60 advanced line

Replication : two

Plot size : 2 m^2 (2.5m × 4 rows)

Planting system/ spacing : Solid seeding
Row to row distance 20 cm
Entry to entry distance 40 cm

Fertilizer dose and methods of application : As per BARC recommendations

Irrigated/rainfed : Irrigated Time Sown (25 November 2020)

Data to be recorded : All crop phenologies including disease, pest, and agronomic scores

Investigators : M M Rahman (Jam), M M Rahman (Raj), M M Rahman (Joy), M A Hakim, M A Alam and M R Islam

Season : 2020-21

Date of Initiation : On-going

Exp. Output/Benefit : Preserved genotypes will be used in future for specific purpose.

Locations : Dinajpur

Status : Started from the beginning of BWMRI

Estimated Cost : Tk. 50,000/-

Source of Fund : BWMRI, DINAJPUR

Plan/Expt. 1.1.7: Bangladesh wheat screening nursery, Set I (BWSN-I)

Objective(s) :
1. To Evaluating all selected advanced lines from national crossing programme for high yield potential with biotic and abiotic stress tolerance
2. Selecting promising lines for evaluation in preliminary yield trial

Rationale : A large number of genotypes are usually selected from different national and international nurseries and trials every year. Handling large number genotypes in yield trials is difficult. So, before yield trials the less important lines are to be discarded. All such selected genotypes is being included in this nursery. Under high selection pressure only the promising lines are selected and promoted for yield testing.

Materials and methods : Seventy lines selected from F6 generation 2018-19 along with BARI Gom 30 and BARI Gom 32 as check will be tested in this nursery. On the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality promising entries will be selected for next evaluation. Crop management practices will be as per recommendation of BWMRI.

Crop/variety	:	Selected wheat lines
Design	:	8 X 9 Alpha-lattice
Treatment	:	72 developed wheat genotypes/lines
Replication	:	2
Plot size	:	2.5 m long X 6 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded		Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc. will be recorded.
Investigators	:	MA Alam, MM Hossain, MR Kabir, MA Hakim — Dinajpur MM Rahman, MM Hasan, MF Amin, MG Faruq — Joydebpur MR Islam — Jashore
Season	:	Rabi 2020-21
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov, 2020 and Irrigated late seeding (ILS)- 20-22 Dec, 2021
Date of Completion		April 2021
Exp. Output/Benefit	:	Promising genotypes will be selected for evaluation in PYT
Locations	:	Dinajpur (SM + Exp), Jashore and Joydebpur
Status	:	1st year
Estimated Cost	:	Tk. 2,00,000/- (Tk. 50,000/- for each location and 50,000/ for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.8: Bangladesh wheat screening nursery, Set II (BWSN-II)

Objective(s)	:	1. Evaluating all selected genotypes/lines from different national and international nurseries for high yield potential 2. Selecting promising lines for evaluation in preliminary yield trial
Rationale	:	A large number of genotypes are usually selected from different national and international nurseries and trials every year. Handling large number genotypes in yield trials is difficult. So, before yield trials the less important lines are to be discarded. All such selected genotypes is being included in this nursery. Under high selection pressure only the promising lines are selected and promoted for yield testing.
Materials and Methods	:	Seventy advance lines selected from ESWYT, IBWSN, SATYN, HTWYT, HPYT, HPSN, SATYT, WYCYT, and SAWYT of 2019-20 along with BARI Gom 21 and BARI Gom 32 as check will be tested. Based on yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality promising entries will be selected for next evaluation. Crop management practices will be as per recommendation of BWMRI.

Crop/variety	:	Selected wheat lines
Design	:	8 X 9 Alpha-lattice
Treatment	:	72 developed /selected wheat genotypes/lines
Replication	:	2
Plot size	:	2.5m long X 6 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded		Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc. will be recorded.
Investigators	:	M R Kabir, MSN Mandal, MM Hossain, MA Alam, MN Alam Dinajpur MM Rahman Jamalpur A Yasmin, MAA Khan, MAA Mamun, and MM Rahman Rajshahi
Season	:	Rabi 2020-21
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov, 2019 and Irrigated late seeding (ILS)- 20-22 Dec, 2019
Date of Completion		April 2021
Exp. Output/Benefit	:	Promising genotypes will be selected for evaluation in Preliminary Yield Trial
Locations	:	Dinajpur (SM + Exp), Jamalpur, and Rajshahi
Status	:	1st year
Estimated Cost	:	Tk. 2,00,000/- (Tk. 50,000/- for each location and 50,000/ for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.9: Preliminary yield trial (PYT)

Objective(s)	:	1. Evaluating yield potential of the promising lines selected from BWSN under different agro climatic conditions 2. Selecting promising lines for Advance Yield Trial
Rationale	:	Best lines from different nurseries may not have the ability to perform well under different environments. Before testing genotypes in Advance Yield Trial over locations the selected promising genotypes which have been selected from BWSN are usually tested in Preliminary Yield Trial (PYT) in different agro climatic conditions. PYT is important to study the adaptation and resistance against biotic and abiotic stresses of the promising lines over locations.
Materials and Methods	:	Advanced lines selected from BWSN Set-I, Set- II and 3rd ZnWYT of 2019-20 along with three check varieties Shatabdi, BARI Gom 32 and BARI Gom 33 will be tested in this trial in optimum and late seeding conditions. Promising lines will be selected on the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and

quality for next trial. Crop management practices will be as per recommendation of BWMRI.

Crop/variety	:	Selected wheat lines
Design	:	Alpha-lattice
Treatment	:	Selected wheat genotypes
Replication	:	2
Plot size	:	5m long X 8 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded		Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc.
Investigators	:	MSN Mandal, MA Alam, MR Kabir, MA Hakim. Dinajpur MM Rahman, Y Abida, MAA Khan, and MAA Mamun Rajshahi MR Islam Jashore
Season	:	Rabi 2020-21
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov, 2020 and Irrigated late seeding (ILS)- 20-22 Dec, 2020
Date of Completion		April 2021
Exp. Output/Benefit	:	Will help to select suitable genotypes for advance yield trial
Locations	:	Dinajpur (Exp + SM), Jashore and Rajshahi
Status	:	On-going
Estimated Cost	:	Tk. 1,50,000/- (Tk. 40,000/- for each set and 30,000/- for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.10: Advance yield trial (AYT)

Objective(s)	:	1. Evaluating yield potential of the advance lines under different locations 2. Selecting promising lines for evaluation in Candidate Variety Demonstration
Rationale	:	Selected lines from PYT are promoted as advance lines every year. Before testing genotypes for evaluation over locations in farmers' fields the selected promising genotypes are usually further tested in Advance Yield Trials (AYT) in different agro climatic conditions to select high yielding, disease resistance/tolerant lines with stable performance under different environmental conditions.
Materials and methods	:	Nine advance lines selected from PYT (2019-20) along with Shatabdi, BARI Gom 32 and BARI Gom 33 will be tested in this trial in optimum and late seeding conditions. Promising lines will be selected on the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality for next trial. Crop management practices will be as per recommendation of BWMRI.

Crop/variety	:	Selected wheat lines	
Design	:	RCBD	
Treatment	:	9 promising wheat genotypes and 3 checks	
Replication	:	3	
Plot size	:	5 m long X 8 rows	
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm	
Fertilizer dose and methods of application	:	As per BARC recommendations	
Irrigated/rainfed	:	Irrigated	
Data to be recorded		Data will be recorded on days to heading, maturity, plant height, visual sterility, disease reactions, TGW, grain yield and visual grain quality etc. under optimum and late seeding conditions.	
Investigators	:	MSN Mandal MR Kabir, MA Hakim, and MM Hossain	Dinajpur
		G Faruq, MM Rahman, MF Amin	Joydebpur
		MM Rahman	Jamalpur
		MR Islam	Jashore
		MAA Mamun, Y Abida, MM Rahman and MAA Khan	Rajshahi
Season	:	Rabi 2020-21	
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-25 Nov, 2020, Irrigated late seeding (ILS)- 20-25 Dec 2019 and	
Date of Completion		April 2021	
Exp. Output/Benefit	:	Will help to select suitable genotypes for candidate variety demonstration	
Locations	:	Dinajpur (Exp + SM), Joydebpur, Jashore, Jamalpur, and Rajshahi	
Status	:	On-going	
Estimated Cost	:	Tk. 5,00,000/- (Tk. 75,000/- for each set and 50,000/- for SM)	
Source of Fund	:	BWMRI, DINAJPUR	
Priority	:	1	

Plan/Expt 1.1.11: Candidate variety demonstration (CVD)

Objective(s)	:	1. Evaluating performances of the promising advance lines in large plots 2. Selecting candidate varieties for on farm and on station multi-location testing.
Rationale	:	This study is the last step for the breeders to evaluate a line before applying to NSB for release as a new variety. Candidate varieties need evaluation by the technical committee of NSB before release. So, the promising candidate varieties selected from AYT will be tested finally at research stations at different growing environments. This program also provides good amount of quality seed of the upcoming variety.

Materials and methods	:	Nine advanced lines selected from AYT and CVD of 2019-20 along with 2 check varieties Shatabdi and BARI Gom 32 will be tested under this trial at 2 locations. Selected line(s) will be released as new variety. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	:	Shatabdi, BARI Gom 32 and 7 advanced lines
Design	:	Non-replicated
Treatment	:	Genotypes
Replication	:	Non-replicated
Plot size	:	5m long X 20 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on days to heading, days to maturity, plant height, disease reaction, spikes per sq. m, grains/spike, TGW, test wt. and grain yield.
Investigators	:	MA Hakim, MA Alam, MR Kabir, MM Hossain and MSN Mandal, MN Alam — Dinajpur MR Islam — Jashore M F Amin — Joydebpur
Season	:	Rabi 2020-21
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov 2020 and Irrigated late seeding (ILS)- 20-22 Dec 2020
Date of Completion	:	April 2021
Exp. Output/Benefit	:	Performance of the candidate varieties over location and environment will be known.
Locations Status	:	Dinajpur and Jashore
Status	:	On-going
Estimated Cost	:	Tk. 1,00,000/- (Tk. 30,000/- per location and 40,000 for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.12: Distinctness, uniformity and stability (DUS) Test

Objective(s)	:	1. Studying the identifying characters of advance lines before release 2. Studying the uniformity and stability of the identifying characters 3. Establishing distinctness of the candidate varieties from the existing varieties with at least one character
Rationale	:	DUS test is a requirement of National Seed Board to release a variety. The candidate varieties must be proved to be distinct from the existing varieties by at least one character. This is also important to establish Breeder's right. So, DUS test of the promising candidate varieties will be performed for two years over locations to study the uniformity of the line and assess the stability in their performance under different environment and management practices.

Materials and methods	:	DUS test will be performed with 15 lines/varieties in collaboration with SCA. Two sets of experiments will be conducted at the experimental farm of BWMRI, Dinajpur and SCA, Joydebpur. Unit plot size: 5m x 6 rows, 2 sets at 15 days interval. Other management practices will be as per recommendation of BWMRI.
Crop/variety	:	Eight advanced lines and 7 varieties
Design	:	RCB
Treatment	:	15 wheat Genotypes/varieties
Replication	:	Non replicated
Plot size	:	5m X 6 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data to be recorded 29 morphological/botanical characters as per procedure and agreement with SCA
Investigators	:	MR Kabir, MA Alam, MM Hossain, MA Hakim Dinajpur Respective personnel from SCA Gazipur
Season	:	Rabi 2020-21
Date of Initiation	:	20-30 Nov 2020
Date of Completion	:	April 2021
Exp. Output/Benefit	:	Distinctness of the new variety will be established.
Locations	:	BWMRI, Dinajpur and SCA, Gazipur
Status	:	On-going
Estimated Cost	:	Tk. 60,000/- (Tk. 20,000/- per location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt. 1.1.13: Adaptive trial with advance wheat lines at MLT sites

Objective(s)	:	1. To see the yield of new wheat lines in comparison to the widely grown check variety in different agro-ecological zones. 2. Evaluate the advance lines by the field evaluation committee of the National Seed Board (NSB).
Rationale	:	It is necessary to know the performance of new wheat lines in different agro-ecological zones and to evaluate those by the members of field evaluation committee of NSB, under farmers' conditions before release as variety.
Materials and methods	:	The trial will be conducted at wheat growing 10 agricultural regions: Dinajpur, Rajshahi, Jashore, Mymensingh, Dhaka and Comilla One set will be grown at the BWMRI station of the respective region except Comilla and 1 set at farmers' fields. Seeds will be sown during 20-30 November. Recommended managements will be followed to raise the crop.

Crop/variety : BARI Gom 32, and an advanced line

Design : RCB

Treatment : Varieties/Genotypes-02

Replication : 3

Plot size : 4m X 5m

Planting system/ spacing : Solid seeding
Row to row distance 20 cm
Entry to entry distance 60 cm

Fertilizer dose and methods of application : As per BARC recommendations

Irrigated/rainfed : Irrigated

Data to be recorded : Data will be recorded on days to heading and maturity, disease reactions, visual sterility (%), grains spike^{-1}, 1000 grain weight, visual grain characteristics, grain yield (from 1m x 1m of 5 samples = 5 m^2), etc.

Investigators :

MA Alam, MM Hossain, MN Alam, MA Hakim,	Dinajpur
MM Rahman, MM Hasan, MF Amin and G. Faruq,	Joydebpur
M M Rahman and MM Hossain	Jamalpur
MR Islam and MB Anwar	Jashore
MM Rahman, Y Abida, MAA Khan, MAA Mamun	Rajshahi
Respective OFRD scientist	Tangail

Season : 2019-2020

Date of Initiation : 20-30 Nov. 2020

Date of Completion : April 2021

Exp. Output/Benefit : Selection of appropriate line(s) for release as variety through testing in farmers' fields under wide ranges of environments will be more adaptable and give more yields. These varieties will help increase wheat yields and production in the country.

Locations :

District	Research Station	Farmer's field	Total trial
Dinajpur	1	1	2
Rajshahi	1	1	2
Jashore	1	1	2
Jamalpur	1	1	2
Joydebpur	1	0	1
Tangail	0	1	1
Faridpur	0	2	2

Status : On-going

Estimated Cost : Tk. 6,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.1.14: On-station demonstration (OSD)

Objective(s)	:	Demonstrating wheat varieties to the visitors under optimum and late seeding conditions
Rationale	:	Maintaining seed of all BWMRI released varieties has historical and scientific importance. Demonstrating comparative performance of the old and newly varieties to the visitors is very important to realize the improved features of the new varieties. This program also provides opportunity to the researchers to monitor the performance of the old and current varieties over the years. Thus it helps making quick decision to maintain or replace a variety.
Materials and methods	:	Twenty-three bread wheat varieties along with one triticale and one durum varieties will be demonstrated at 5 regional stations of BWMRI across the country. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	:	BWMRI released wheat varieties
Design	:	Non-replicated
Treatment	:	Varieties-25
Replication	:	Non-replicated
Plot size	:	5m X 6 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on Heading, Plant height, maturity, spikes/sq.m, grains/spike, TGW and disease scores etc.
Investigators	:	MM Hossain, MN Alam — Dinajpur MF Amin — Joydebpur MM Rahman and MM Hossain — Jamalpur MAA Mamun, MAA Khan, A Yasmin, MM Rahman — Rajshahi
Season	:	Rabi 2020-21
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov 2020 and Irrigated late seeding (ILS)- 20-22 Dec 2020
Date of Completion	:	April 2021
Exp. Output/Benefit	:	Performance of the wheat varieties over location will be known.
Status	:	On-going
Estimated Cost	:	Tk. 2,00,000/-
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.15: Genetic gain of wheat varieties in Bangladesh

Objective(s)	:	To compare the yield performance of recently released wheat varieties with previous mega varieties
Rationale	:	Wheat is the second most important staple food crop in Bangladesh after rice and its consumption is increasing 10% per year. BWMRI has so far developed 32 wheat varieties till 2017. Rapid adoption of new varieties and other improved production technologies causing a substantial yield

increase in recent years, and the ever-highest national average yield of 3.10 t/ha. This yield increase was realized by significant contributions in both genetic values of the varieties used and improved agronomy, irrigation and fertilization. It is important to document the genetic gains in grain yield of recently released varieties under sprayed and unsprayed with Irrigated Timely Sown (ITS) and Irrigated Late Sown (ILS) conditions to assist in developing future breeding strategies.

Materials and methods : Eleven wheat varieties (Sonalika, Kanchan, Prodip, BARI Gom 26, BARI Gom 28, BARI Gom 30, BARI Gom 32, BARI Gom 33, WMRI Gom 1, WMRI Gom 2 and WMRI Gom 3) will be used in this study to evaluate under sprayed (Fungicide) and unsprayed (control) conditions. Each entry will be grown in 5m long 6rows with row spacing of 20cm keeping 60cm between varieties and 1m between blocks. The experiment will be laid out in split plot design with spray in the main plot and varieties in the sub plot with 3 replications. The same trial will be conducted both in ITS and ILS conditions. Fertilizer will be applied @ 120-60-40-20 NPKS kg/ha. Two-third of N and all others fertilizes will be applied as basal before final land preparation. Rest one-third of N will be top dressed at CRI stage (17-21 DAS) with light irrigation. Recommended managements will be followed to raise the crop. Data will be recorded on days to heading, maturity, plant height, grains/spike, diseases, 1000-grain weight and yield.

Crop/variety : Wheat mega verities and new varieties

Investigators : MA Alam, MA Hakim, MSN Mandal, MM Hossain, MA Reza

Season : 2019-20

Date of Initiation : November, 2020

Date of completion April, 2021

Exp. Output/Benefit : To know the yield potential of newly released wheat varieties which will help to plan new research program for developing new wheat varieties under sprayed and unsprayed conditions.

Locations : Bangladesh Wheat and Maize Research Institute, (BWMRI), Dinajpur

Status : New

Estimated Cost : Tk. 5,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

SUB-PROJECT 1.2: DEVELOPMENT OF HEAT TOLERANT WHEAT GENOTYPES

In Bangladesh, most of the wheat (>60%) is grown under late sowing condition (December sowing) that exposes the plants in high temperature at reproductive stage. This exposure to late heat causes abortion of the florets and forces ripening of the underdeveloped kernels. Late planting also results in acceleration of leaf senescence and low kernel weight and subsequently, low grain yield is observed. In some areas farmers are interested to sow wheat early i.e. 1st week of November to save utilize residual soil moisture that causes early heat stress. Therefore, major emphasis has been given to develop late/terminal heat tolerant varieties in the Wheat Breeding Programme. However, recently due attention has also been given to develop early heat tolerant varieties.

Plan/Expt. 1.2.1	**:**	**8th Early heat tolerance wheat screening nursery (8th EHTWSN)**
Objective(s)	**:**	1. Evaluating selected promising genotypes for early heat tolerance and high yield potential in early seeding 2. Selecting promising lines for inclusion in preliminary yield trial and/or using as parent
Rationale	**:**	A large amount of wheat growing lands become available for sowing in late October to early November due to expansion of short duration rice varieties. But seeding of wheat at this period has not been recommended yet. Temperature remains comparatively high at this period which has detrimental effect during germination and crop establishment stages causing considerable yield loss. Heat stress during early crop growth is called "Juvenile heat stress" which causes less biomass, less tillering i.e. poor crop stand, shortened vegetative period i.e. early heading with less number of grains per spike and reduced spike length. Sometimes optimum sown wheat also suffers from early heat stress. Usually, farmers don't like to hold their land empty for long time to avoid loss of residual soil moisture. Variability for heat tolerance exists in spring wheat. Development of early heat tolerant wheat line/variety has great potential to increase the area and productivity of wheat
Materials and methods	**:**	PYT lines with 3 checks (Shatabdi, BARI Gom 30 & BARI Gom 32). Materials will be tested at 2 locations. The crop will be grown using BWMRI recommended management technologies.
Crop/variety	**:**	Wheat
Design	**:**	5X6 Alpha-lattice, 2 reps.
Treatment	**:**	30 wheat genotypes/varieties
Plot size	**:**	2.5m X 4 rows
Planting system/spacing	**:**	Solid seeding, row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated Early seeding (IES)- 20 Oct- 7 Nov 2020
Data to be recorded	**:**	Data will be recorded on days to heading and maturity, plant height, early vigor, initial plant population, EGC, biomass, disease reaction, visual sterility, CT and SPAD value, NDVI, number of spikes m^{-2}, spikelet per spike, grain per spike, 1000-grain weight, physical grain characteristics and grain yield etc. Soil moisture from sowing to tillering will be monitored.
Investigators	**:**	MM Hossain, MN Alam, MA Alam — Dinajpur MAA Mamun, Y Abida ,MM Rahman, and MAA Khan — Rajshahi
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	October 2020
Date of Completion	**:**	April 2021
Exp. Output/Benefit	**:**	Will help to select promising high yielding genotypes suitable for early sowing.
Locations	**:**	Dinajpur and Rajshahi
Status	**:**	On-going

Estimated Cost	:	Tk. 1,00,000/- (Tk. 50,000/- per location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1
Plan/Expt. 1.2.2	:	**Heat tolerant wheat yield trial (HTWYT)**
Objective(s)	:	Evaluating selected promising genotypes for late heat tolerance and high yield potential in late seeding.
Rationale	:	Heat stress is one of the major environmental constraints for wheat production worldwide. High temperature during grain filling in wheat leads to a significant reduction in yield. The mean temperature increasing due to global warming causes the wheat production down globally. Heat stress during the heading stage most severely reduces floret fertility and thereby yield. Crop failures and yield reduction due to heat stresses are predicted to increase due to increasingly variable climate and the frequency of severe weather events. It is therefore important to develop wheat varieties with tolerance to heat stress.
Materials and methods	:	30 advanced line including 3 checks (BARI Gom 30, BARI Gom 32 & WMRI Gom 1) will be tested at three locations for late heat stress.
Crop/variety	:	Wheat
Design	:	5X6 Alpha-lattice, 2 reps.
Treatment	:	30 wheat genotypes/varieties
Plot size	:	2.5m X 4 rows
Planting system/spacing	:	Solid seeding, Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated Late seeding (IVLS)- 01-10 Jan 2020
Data to be recorded	:	Data will be recorded on days to heading and maturity, plant height, early vigor, initial plant population, EGC, biomass, disease reaction, visual sterility, CT and SPAD value, NDVI, number of spikes m^{-2}, spikelet per spike, grain per spike, 1000-grain weight, physical grain characteristics and grain yield etc. Soil moisture from sowing to tillering will be monitored.
Investigators	:	MA Alam and MA Hakim — Dinajpur MM Rahman and G Faruq — Joydebpur MR Islam — Jashore
Season	:	Rabi 2020-21
Date of Initiation	:	November 2020
Date of Completion	:	April 2021
Exp. Output/Benefit	:	Will help to select promising high yielding genotypes suitable for early sowing.
Locations	:	Dinajpur, Joydebpur and Jashore
Status	:	On-going
Estimated Cost	:	Tk. 1,00,000/- (Tk. 50,000/- per location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

SUB-PROJECT 1.3	**:**	**DEVELOPMENT OF DROUGHT TOLERANT WHEAT GENOTYPES**
Experiment 1.3.1.	**:**	**8th Drought tolerant yield trial**
Objectives	**:**	1. To evaluate new exotic lines against drought under Bangladesh condition. 2. To identify the appropriate germplasms tolerant to drought stress
Rationale		Drought is a serious problem for agriculture all around the world and water shortage is now becoming the number one ecological predicament facing mankind. It appears that about 90% of total wheat area in the country is irrigated and the rest are cultivated under rain-fed condition (BBS, 2012). The BWMRI has so far developed 28 high yielding varieties those are suitable for irrigated condition. Potentiality may exist among these cultivars and other advanced lines for further genetic manipulation for dry environments. But efforts to identify drought tolerant varieties and then incorporate the tolerance characters into varieties for improvement have so far not been made at least systematically in Bangladesh. New varieties need to be developed that can withstand adverse climatic condition, particularly the soil moisture stress in order to produce satisfactory yield per unit are. An emphasis should be given to collect and evaluate of new exotic lines against drought under Bangladesh condition. This study will help to identify the appropriate germplasms tolerant to drought stress and also will help in designing future improvement program for the development of drought tolerant varieties.
Materials and methods	**:**	Selected lines from 37th SAWSN along with 2 check varieties will be included in this trial.
Crop/variety	**:**	Wheat
Design	**:**	Alpha lattice
i. Treatment	**:**	Selected wheat genotypes/varieties including 2 checks
ii. Replication	**:**	2
Plot size	**:**	5m X 6 rows
Planting system/spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations.
Irrigated/rainfed	**:**	The trial will be conducted under Irrigated and rain-fed conditions. Irrigated plots will be watered as per recommendation of BWMRI (CRI, awn peeping and grain filling stage). Non-irrigated plots will be grown under rain-fed condition. All the experiments fields will be well watered after sowing to ensure germination.
Season	**:**	Rabi, 2019-20
Date of initiation	**:**	November, 2020
Date of completion	**:**	April 2021
Exp output/benefit	**:**	This study will help to identify the appropriate germplasms tolerant to drought stress and also will help in designing future improvement program for the development of drought tolerant varieties.
Location	**:**	Rajshahi

Investigators		MM Rahman, MAA Khan, Y Abida, MAA Mamun
Status	**:**	On-going
Estimated cost	**:**	Tk. 80,000/-
Source of fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1
Plan/Exp. 1.3.2.	**:**	**Evaluation of drought tolerant advanced lines in Barind area**
Objectives	**:**	To identify the appropriate elite genotypes that tolerant to drought stress environment.
Rationale	**:**	New wheat varieties need to be developed that can withstand adverse climatic condition, particularly the soil moisture stress in order to produce satisfactory yield per unit area Emphasis should be given to collect and evaluate of new exotic lines against drought under Bangladesh condition. This study will to select appropriate elite genotypes tolerant to drought stress environment.
Materials and methods	**:**	Selected lines from last year DYT and check variety
Crop/variety	**:**	Drought tolerant wheat genotypes
Design	**:**	Dispersed RCB
i. Treatment	**:**	Selected wheat genotypes
ii. Replication	**:**	3 (on farm)
Plot size	**:**	5m X 6 rows
Planting system/spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	100:27:50: 20:1 NPKSB Kg/ha
Irrigated/rainfed	**:**	The trial will be conducted under rain-fed condition.
Data to be recorded	**:**	Soil characteristics data along with Initial plant population, plant height, days to anthesis, days to maturity, ground coverage, no. of spikes/m^2, no. of grains/spike, peduncle length, spike length, weight of spike, biomass at harvest, RWC%, % Dry matter, 1000-grain weight and grain yield.
Season	**:**	Rabi, 2020-21
Date of initiation	**:**	November 2020
Date of completion		April, 2021
Location	**:**	On-station, Saphahar, Godagari Upa-zillas
Investigators		MAA Mamun, AA Khan, MM Rahman, MA Hakim, G Faruq
Expected output	**:**	This study will help to identify the appropriate germplasms tolerant to drought stress and to develop drought tolerant varieties.
Status	**:**	On-going
Estimated cost	**:**	Tk. 1,00,000/-
Source of fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

SUB-PROJECT 1.4 : MOLECULAR AND DOUBLE HAPLOID BREEDING

Plan/Exp. 1.4.1 : Production of wheat double haploids

Objective(s) :
1. To develop immediate homozygosity of segregated lines.
2. To reduce breeding time for variety release.
3. To improve efficacy and efficiency in screening for resistance.

Rationale : Haploids are of great interest as breeding tools in cereal improvement, especially in wheat breeding programme. One goal of recent biotechnology research is to obtain doubled haploid plants which offer complete homozygosity and phenotypic uniformity in one generation. Another advantage is a substantial reduction in the cost and the time required to produce breeding lines by conventional system. Haploid plants can be obtained from male or female gametic cells. Plant breeders are increasingly using this system in their mainstream programs in a large number of major crops.

Materials and Methods : Ten F1 hybrids will be used as experimental materials. Major steps to be followed:

- ✓ Crossing between F_1 wheat ovary x maize pollen
- ✓ Application of growth hormone to enhance embryo-growth
- ✓ Embryo rescue
- ✓ Regeneration of haploids through tissue culture
- ✓ Production of doubled haploids

Investigators : MF Amin, MG Faruq, MM Rahman

Season : Rabi, 2020-21

Date of Initiation : November 2020

Date of completion April 2021

Exp. Output/Benefit : With DH system, homozygosity will be achieved in a single generation and thus reduce breeding time for variety release

Locations : RS research field, Biotechnology division lab & green house, BARI, Joydebpur

Status : On-going

Estimated Cost : Tk. 1,50,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.4.2 : Molecular characterization of wheat advanced lines using SSR markers

Objective(s) :
1. To study genetic variation among wheat varieties using chromosome specific SSR markers
2. To find genetically most diverse genotypes of wheat which can further be used in hybridization programs to create genetically diverse germplasm.

Rationale : In order to sustain high levels of wheat production in Bangladesh, the most important requirements are the maintenance of a diverse pool of wheat cultivars where 'superior' gene/alleles can be obtained for genetic improvement programs. Intensive activities aimed at improving wheat crop such as selection of cultivars with desirable attributes have led to a reduced genetic diversity over time.

Microsatellite markers also called simple sequence repeats (SSR) or short tandem repeats (STR) are among the most popular molecular markers used in genetic diversity studies. This type of markers is characterized by its high efficiency, reproducibility, codominant nature and high degree of polymorphism. Microsatellites are vital in cultivar identification and also offer an advantage during pedigree analysis as they are genus specific. Several studies conducted to identify the genetic diversity of wheat cultivars using SSRs, had shown consistent results with the polymorphism expressed being significantly more reliable than that reported using other types of markers.

Materials and methods : 54 wheat genotypes will be used in this study. Ten seeds of each wheat genotype will be grown in pot and DNA will be extracted from 15 days old wheat seedlings using CTAB method. About fifty SSR markers will be selected covering each of the seven linkage groups. PCR will be performed. SSR protocol for 6% poly-acrylamide gel electrophoresis (PAGE) will be performed. The gel glass will be stained in 1500 ml of water containing 3 g silver nitrate solution. Thereafter, the alleles will be enhanced in 2000 ml of water solution containing 3 ml of 37% formaldehyde (H2CO) and 30 g sodium hydroxide. All clearly amplified alleles on the genotypes will be treated as a single locus. Scoring will be based on presence and absence of the alleles.

Bivariate 1 and 0 data matrices obtained from the stained gel will be used to construct a dendrogram based on the genetic similarity coefficient. Sahn-clustering of un-weighted pair-group method with arithmetic average (UPGMA) will be applied using the software NTSYSpc 2.1 (Numerical Taxonomy and Multivariate Analysis System), version 2.1. Polymorphism information content (PIC) will be calculated using the following formula:

$$Hi = 1 - \sum_{j=1}^{n} x^2 ij$$

Where $x^2 ij$ is the frequency of the jth allele for marker i and summation extends over n alleles

Investigators : MA Alam, MM Hossain, MA Hakim, MR Kabir

Season : Rabi 2020-21

Date of Initiation : October 2020

Exp. Output/Benefit : Characterization and assessment of the genetic diversity of Bangladeshi wheat varieties. Providing useful information for the conservation of genetic resources and the enhancement of wheat breeding.

Locations : BWMRI, Dinajpur

Status New

Estimated Cost : Tk. 5,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.4.3 : **Molecular screening of blast resistance wheat genotypes using 2NS markers**

Rationale : Wheat blast is a serious disease caused by a host-specialized population of the ascomycete *Magnaporthe oryzae* B.C. Couch and L.M. Kohn (synonym *Pyricularia oryzae*). It was first reported on wheat (*Triticum aestivum* L.) in 1985 in Paraná, Brazil and has since spread throughout many of the important wheat-producing areas of Brazil and to the neighboring countries of Bolivia and Paraguay. Blast is now considered a major threat to wheat production in South America. In February 2016, a new fungal disease was spotted in wheat fields across eight districts in Bangladesh. The epidemic spread to an estimated 15,000 hectares, about 16 % of the cultivated wheat area in Bangladesh, with yield losses reaching up to 100 %. Cultivars derived from the CIMMYT line Milan appear to contain high levels of resistance under field conditions (Kohli et al., 2011). The genetic basis of the resistance in Milan has not yet been established (Kohli et al., 2011). Other cultivars with this resistance source are now being widely deployed, but it remains to be seen how long this resistance will be effective (Kohli et al., 2011). Thus, there is a critical need for identification of new sources of resistance to wheat blast. The blast resistance genes come from *Aegilops ventricosa* (Zhuk.) Chennav on wheat. This translocation carries a 25 to 38 cM distal segment of chromosome arm 2NS from *Aegilops ventricosa* to the distal region of chromosome arm 2AS in wheat. The *Ae. ventricosa* 2NS/2AS translocation carries resistance genes *Rkn3* against root-knot nematodes (*Meloidogyne* spp.), *Cre5* against the French pathotype *Ha12* of the cereal cyst nematode (*Heterodera avenae* Wollenweber), and *Lr37, Sr38*, and *Yr17* against some races of wheat leaf, stem and stripe rust.

Materials and methods : Materials: One thousand wheat genotypes collected from international wheat screening nursery will be used in this study.

Methods:

Genomic DNA extraction: To amplify 2NS translocation genomic DNA will be extracted from 10 days old wheat seedlings using CTAB method.

PCR Amplification and gel electrophoresis: Two PCR primers (VENTRUIP-F/LN2-R and Yr17-F/Yr17-R) will be used for screening wheat blast resistance genes in 2NS segment of wheat germplasms. PCR will be performed in a volume of 10 µL using a Verity Thermal Cycler (Applied biosystems, USA). The reaction mixture will be contained 40 to 100 ng of genomic DNA, 2× PCR master mix, 10 µM each Primer and ddH_2O up to 10 µL. The amplification program of VENTRUIP-F/LN2-R will be as follows: 94°C for 3 min (enzyme activation); 30 cycles of 94°C for 45 sec (melting), 65°C (depending on the specific primers) for 30 sec (annealing) and 72°C for 60 sec (extension); and a final extension at 72°C for 7 min. The amplification program of Yr17-F/Yr17-R will be as follows: 94°C for 3 min (enzyme activation); 26 cycles of 94°C for 45 sec (melting), 57°C (depending on the specific primers) for 45 sec (annealing) and 72°C for 45 sec (extension); and a final

extension at 72°C for 8 min. . PCR products (10 µl each) will be run on 1.5% agarose gel and will be stained with ethidium bromide.

Investigators : MA Alam, MR Kabir, MA Hakim, MM Hossain, MSN Mandal
Season : Rabi
Date of Initiation : November 2020
Exp. Output/Benefit : Research findings of this experiment will be helpful for detecting 2NS translocated wheat genotypes for developing high yielding wheat varieties with resistance to blast through markers assisted selection.
Location : Breeding lab. of BWMRI
Status : On-going
Estimated Cost : Tk. 200000/-
Source of Fund : BWMRI
Priority : 1

Plan/Expt 1.4.4 : **Screening of superior 20 wheat genotypes for their potentiality towards heat, salinity and drought using published molecular markers**

Objectives Identifying of superior genotypes towards heat, drought and salinity stress for increasing wheat areas horizontally.

Rationale : Due to current crop competition and sustainability of wheat in Bangladesh it is essential to its extension in nontraditional areas. With that intension last few years BWMRI had started work on it and phenotypically identify few potential wheat lines against these abiotic stresses. Now it is obligatory task to confirm their features against these stresses. Using of published potential molecular markers could be a good source of screening.

Materials and methods : Materials: A total of twenty selected advanced lines/ varieties plant materials after basic screening at different stations of BWMRI together at the headquarter at Dinajpur
Methods:
Genomic DNA extraction
DNA will be extracted by CTAB method or using commercial kits
PCR Amplification and gel electrophoresis:
Will be optimized based on the primers and other conditions

Investigators : MM Rahman, M Khan (From Agronomy) and G. Faruq
Season : Rabi
Date of Initiation : November 2020
Exp. Output/Benefit Potential Advance lines / Varieties towards against Heat, Drought and Salinity stresses will be perfectly identified through through a phenotypic and molecular screening. those could be sued at the mentioned abiotic stress prone areas
Location Integrated Breeding Laboratory at Gazipur of BWMRI
Status New
Estimated Cost Tk. 300000/-
Source of Fund BWMRI
Priority 1

Plan/Expt 1.4.5 : **Selection of blast resistant individuals from different filial generations through MAS**

Rationale : Wheat blast is a serious disease caused by a host-specialized population of the ascomycete *Magnaporthe oryzae* B.C. Couch and L.M. Kohn (synonym *Pyricularia oryzae*). It was first reported on wheat (*Triticum aestivum* L.) in 1985 in Paraná, Brazil and has since spread throughout many of the important wheat-producing areas of Brazil and to the neighboring countries of Bolivia and Paraguay. In February 2016, a new fungal disease was spotted in wheat fields across eight districts in Bangladesh. The epidemic spread to an estimated 15,000 hectares, about 16 % of the cultivated wheat area in Bangladesh, with yield losses reaching up to 100 %. The blast resistance genes come from *Aegilops ventricosa* (Zhuk.) Chennav on wheat. This translocation carries a 25 to 38 cM distal segment of chromosome arm 2NS from *Aegilops ventricosa* to the distal region of chromosome arm 2AS in wheat. The *Ae. ventricosa* 2NS/2AS translocation carries resistance genes *Rkn3* against root-knot nematodes (*Meloidogyne* spp.), *Cre5* against the Frenchpathotype *Ha12* of the cereal cyst nematode (*Heterodera avenae* Wollenweber), and *Lr37*, *Sr38*, and *Yr17* against some races of wheat leaf, stem and stripe rust. Therefore, this is important to select blast resistant individuals in different filial generation (F_1 to F_6) using 2NS primers.

Materials and methods : Materials: Individuals of different filial generation (F_1 to F_6) will be used in this study.

Methods:

Genomic DNA extraction: To amplify 2NS translocation genomic DNA will be extracted by CTAB method.

PCR Amplification and gel electrophoresis: Two PCR primers (VENTRUIP-F/LN2-R and Yr17-F/Yr17-R) will be used for selecting 2NS translocated individuals from different filial generations. PCR will be performed in a volume of 10 µL using a Verity Thermal Cycler (Applied biosystems, USA). The reaction mixture will be contained 40 to 100 ng of genomic DNA, 2× PCR master mix, 10 µM each Primer and ddH_2O up to 10 µL. The amplification program of VENTRUIP-F/LN2-R will be as follows: 94°C for 3 min (enzyme activation); 30 cycles of 94°C for 45 sec (melting), 65°C (depending on the specific primers) for 30 sec (annealing) and 72°C for 60 sec (extension); and a final extension at 72°C for 7 min. The amplification program of Yr17-F/Yr17-R will be as follows: 94°C for 3 min (enzyme activation); 26 cycles of 94°C for 45 sec (melting), 57°C (depending on the specific primers) for 45 sec (annealing) and 72°C for 45 sec (extension); and a final extension at 72°C for 8 min. . PCR products (10 µl each) will be run on 1.5% agarose gel and will be stained with ethidium bromide.

Investigators : MA Alam, MR Kabir, MA Hakim, MM Hossain, MSN Mandal

Season : Rabi

Date of Initiation : November 2020

Exp. Output/Benefit : Research findings of this experiment will be helpful for selecting individuals from 2NS X Non-2NS and 2NS X 2NS cross to develop high yielding wheat varieties with resistance to blast through markers assisted selection (MAS).

Location : Breeding lab. of BWMRI

Status : New

Estimated Cost : Tk. 400000/-

Source of Fund : BWMRI

Expt 1.4.6	**:**	**Improving drought tolerance using marker-assisted recurrent selection**
Objective(s)	**:**	To develop and deliver wheat varieties to the wheat growers with enhanced levels of tolerance to drought stress controlled by many minor genes and QTLs.
Rationale	**:**	Most identified QTL for drought tolerance represents only a small portion of phenotypic variability, with many minor genes contributing to the plant response to the stresses. Attempting to combine these genes and QTL using traditional breeding strategies have generally proven ineffective, and therefore novel breeding strategies are required to more efficiently transfer resistance and tolerance into adapted backgrounds. Using a marker assisted recurrent selection (MARS) strategy can assist with pyramiding these many minor genes together. This technique has been successfully applied to cross pollinated crop like sunflower, soybean and maize to bring desirable alleles into single elite lines, and it is proposed that a MARS strategy would also be effective in pyramiding the many minor genes controlling the drought response.
Materials and Methods	**:**	Diverse parental wheat lines providing some extent of tolerance to drought stress will be grown. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Five heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top. Crop management practices will be as per recommendation of WRC. A (base) population will be derived from a top cross between three resistant parents. This population will be advanced to the F2 generation, where plants will be selected from a bulk population on the basis of BpLB and agronomic adaptability. These selected plants will be grown as F2:3 single rows in the following generation and genotyped using a 90K Single Nucleotide Polymorphism (SNP) platform. A resistant and tolerant phenotype will be produced in F2:4 and F2:5 using adult plant field data. An association analysis will be completed, estimating marker affects for key loci controlling tolerance. On the basis of these marker effects, simple and complex crosses will be made amongst selected progeny containing corresponding marker alleles. These inter crosses derived progeny will be genotyped for the previously identified significant makers using a KASP marker panel of significant markers. Plants accumulating significant markers for resistance and tolerance from the recombination will be used to produce double haploids (DH), using the wheat-maize system, to fix all loci. These double haploid derived lines will be phenotyped for drought tolerance and compared against both the recombinant parents and parents of the base population, to assess whether accumulating minor genes has influenced plant response to drought stress.
Crop/variety	**:**	Drought tolerant wheat genotypes
Design	**:**	As required
i. Treatment	**:**	Genotype and inoculum
ii. Replication	**:**	As required
Plot size	**:**	As required
Planting system/spacing	**:**	As required

Fertilizer dose and methods of application	:	The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha-1 respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.
Irrigated/rainfed	:	As required
Data to be recorded	:	Traits conferring tolerance
Investigators	:	MM Rahman, AA Khan, MA Hakim, MR Kabir
Season	:	Rabi 2020-21
Date of Initiation	:	15 November 2020
Date of completion	:	April 2021
Exp. output/benefit	:	Desirable gene recombination will be generated
Locations	:	Cross: Raj Single cross: 24 Top cross: - Total: 24
Status	:	New
Estimated Cost	:	Location: RWRC, Rajshahi; Land area (m^2): 1000; Cost (Tk.): 80,000/-
Source of Fund	:	BWMRI and BARC
Priority	:	1

SUB-PROJECT 1.5	:	**DEVELOPMENT OF BLAST RESISTANT/TOLERANT VARIETY**
Plan/Expt 1.5.1	:	**Development of blast resistant/tolerant variety**
Objective(s)	:	To develop blast resistant/tolerant variety through 2NS and Non 2NS crossing.
Materials and methods	:	Fifty 2NS X Non 2NS cross and 5 2NS X 2NS crosses will be done in BWMRI Dinajpur. Blast resistant/tolerant wheat lines containing 2NS segment will be crossed with adapted wheat varieties and lines. The F1 generated from the cross will be evaluated next year in Jashore for Blast resistance and will be confirmed for the presence 2NS segment at molecular level.
Crop/variety	:	BARI Gom 30, BARI Gom 33, WMRI Gom 2, WMRI Gom 3 and 5 advanced lines
Design	:	N/A
i. Treatment	:	Wheat varieties/line
ii. Replication & Plot size	:	N/A
Planting system/spacing	:	N/A
Fertilizer dose and methods of application	:	N/A

Irrigated/rainfed	**:**	N/A
Data to be recorded	**:**	N/A
Investigators	**:**	MA Hakim, MA Alam, and MR Kabir
Season	**:**	2019-20
Date of Initiation	**:**	Nov. 2019
Date of completion		April, 2020
Exp. Output/Benefit	**:**	F1 will be generated for wheat blast resistance/tolerance
Locations	**:**	BWMRI, Nashipur, Dinajpur
Status	**:**	New
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt 1.5.2	**:**	**Confirmation and evaluation of 2NS X Non 2NS and 2NS X 2NS F_1 in Jashore**
Objective(s)	**:**	To confirm the crosses, generate F_2 seeds and making top and back crosses utilizing the F1 populations.
Materials and methods	**:**	F1 of target crossed
Crop/variety	**:**	F_1 from 2NS X Non 2NS cross and 2NS X 2NS cross
Design	**:**	N/A
Treatment	**:**	Wheat varieties/lines
Replication & Plot size	**:**	N/A
Planting system/spacing	**:**	N/A
Fertilizer dose and methods of application	**:**	N/A
Irrigated/rainfed	**:**	N/A
Data to be recorded	**:**	N/A
Investigators	**:**	MR Islam and MR Kabir — Jashore M N Alam, MA Alam and MA Hakim, — Dinajpur
Season	**:**	2020-21
Date of Initiation	**:**	Nov. 2020
Date of completion		April, 2021
Exp. Output/Benefit	**:**	F1 will be confirmed and F_2 seed will be generated for top and back cross
Locations	**:**	BWMRI, RARS, Jashore, and Bangladesh Wheat and Maize Research Institute, BARI, Dinajpur

Status	**:**	New
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Expt. 1.5.3	:	**Accelerating wheat breeding program through cutting-edge genomics and phenomics technologies**
Objective(s)	:	1. Early generation selection for grain yield and quality using genomic prediction and high-throughput phenotyping in the wheat breeding program. 2. Improved prediction models for multi-environment predictions within national programs. 3. Increased breeding capacity of national wheat breeding programs.
Rationale	:	Wheat remains one of the most important food crops, providing protein and calories as a second staple for millions throughout Bangladesh. Implementation of advanced breeding approaches in the national wheat programs for capacity development and delivery, enable breeders to select from a much larger set of materials can increase the overall rate of genetic gain, leading to faster development of superior new varieties.
Materials and Methods	:	
Crop/variety	:	Each season six hundred advanced wheat lines will be collected from CIMMYT, Mexico.
Design	:	Alpha lattice
Replications	:	2
Plot size	:	5 sq.m (Jamalpur), 2 sq.m (Dinajpur) and hill plots of 0.6 m^2 (Jashore)
Fertilizer dose and method of application	:	100-26-50-20-5-1 kg ha-1 N-P-K-S-Zn-B for wheat in irrigated condition. Two-third of N and whole amount of other nutrients will be applied as basal and rest of N will be top-dressed after irrigation at CRI stage.
Irrigated/Rainfed		Irrigated
Data to be recorded	:	All crop phonological data including NDVI and CT using UAV.
Investigator(s)	:	MM Rahman — Jamalpur MA Hakim — Dinajpur R Islam — Jashore
Season	:	2019-20
Date of Initiation	:	November 2020
Date of completion	:	April 2023
Exp. Output/Benefit	:	Increased genetic gain and faster variety development
Locations	:	RARS, Jamalpur, Jashore, and BWMRI, Dinajpur.
Status	:	New
Estimated Cost	**:**	4,00,000/-
Source of Fund	**:**	USAID/BWMRI
Priority	**:**	1

Remarks	**:**	
Expt. 1.5.4	**:**	**Multilocation testing of selected wheat lines from genomic selection trials**
Objective(s)	**:**	To evaluate the performance of promising wheat lines with a view to providing information for releasing them as variety
Rationale	**:**	The KSU-BWMRI collaboration is aimed to develop heat tolerant wheat variety for Bangladesh through the application of cutting-edge genomics and phenomics. The CIMMYT, Mexico is a partner of the Kansas State University's project who has a strong vision and program to develop heat tolerant wheat variety for South Asia. Through this strong collaboration, we are getting a lot of promising lines which cumulated about 3000 in last five years to evaluate them in different areas of Bangladesh. Many of the tested lines were superior yielder than our national best check varieties. It facilitated us to get superior parent to make crosses or directly release them as variety.
Materials and Methods	**:**	
Crop/variety	**:**	Six advanced wheat lines selected from genomic selection trial
Design	**:**	RCBD
Replications	**:**	3
Plot size	**:**	5m X 8 rows
Fertilizer dose and method of application	**:**	As per recommendation
Irrigated/Rainfed		Irrigated
Data to be recorded	**:**	All crop phenologies including pathological and agronomic scores
Investigator(s)	**:**	M M Rahman,, M M Hossain (Jam) M R Kabir, MA Alam and M A Hakim (Din) MR Islam (Jas)
Season	**:**	2020-21
Date of Initiation	**:**	Irrigated Time Sown (25 November 2020) Irrigated Late Sown (25 December2020)
Date of completion	**:**	April 2021
Exp. Output/Benefit	**:**	Increased genetic gain and faster variety development
Locations	**:**	RARS, Jamalpur, Jashore, and BWMRI, Dinajpur.
Status	**:**	New
Estimated Cost	**:**	10,00,000/-
Source of Fund	**:**	BWMRI/KSU-BWMRI
Priority	**:**	1

Expt 1.5.5 : **Improving wheat blast resistance and/or tolerance using marker-assisted recurrent selection**

Objective(s) : To develop and deliver wheat varieties to the wheat growers with enhanced levels of resistance and tolerance to wheat blast controlled by many minor genes and QTLs.

Rationale : Attempting to combine many minor genes and QTL using traditional breeding strategies have generally proven ineffective, and therefore novel breeding strategies are required to more efficiently transfer resistance and tolerance into adapted backgrounds. Using a marker assisted recurrent selection (MARS) strategy can assist with pyramiding these many minor genes together. This technique has been successfully applied to cross pollinated crop like sunflower, soybean and maize to bring desirable alleles into single elite lines, and it is proposed that a MARS strategy would also be effective in pyramiding the many minor genes controlling the blast resistance/tolerance.

Materials and Methods : Diverse parental wheat lines providing some extent of resistance to wheat blast (4 parents having 2NS based resistance, 2 parents with non 2NS based resistance) will be grown. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Five heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top. A total 10 crosses will be made. Crop management practices will be as per recommendation of BWMRI.

A (base) population will be derived from a top cross between three resistant parents. This population will be advanced to the F_2 generation, where plants will be selected from a bulk population on the basis of BpLB and agronomic adaptability. These selected plants will be grown as $F_{2:3}$ single rows in the following generation and genotyped using a 90K Single Nucleotide Polymorphism (SNP) platform. A resistant and tolerant phenotype will be produced in $F_{2:4}$ and $F_{2:5}$ using adult plant field data.
An association analysis will be completed, estimating marker affects for key loci controlling wheat blast resistance and tolerance. On the basis of these marker effects, simple and complex crosses will be made amongst selected progeny containing corresponding marker alleles. These inter crosses derived progeny will be genotyped for the previously identified significant makers using a KASP marker panel of significant markers.
Plants accumulating significant markers for resistance and tolerance from the recombination will be used to produce double haploids (DH), using the wheat-maize system, to fix all loci. These double haploid derived lines will be phenotyped for wheat blast and compared against both the recombinant parents and parents of the base population, to assess whether accumulating minor genes has influenced plant response to biotic and abiotic stresses.

Crop/variety : Wheat (Blast resistant and tolerant wheat genotypes)
Design : As required
i. Treatment : Genotype and inoculum
ii. Replication : As required
Plot size : As required
Planting system/spacing : As required

Fertilizer dose and methods of application : The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha^{-1} respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.

Irrigated/rainfed : As required

Data to be recorded : Traits conferring resistance and tolerance

Investigators : MM Rahman, MAA Khan, MA Hakim , MA Alam

Season : Rabi 2020-21

Date of Initiation : 15 November 2020

Date of completion : April 2021

Exp. output/benefit : Desirable gene recombination will be generated

Locations :

Cross	Raj
Single cross	10
Top cross	-
Total	10

Status : New

Estimated Cost :

Location	Land area (m^2)	Cost (Tk.)
RBWMRI, Rajshahi	1000	80,000/-
Jashore	-	-
Total	1,000	80,000/-

Source of Fund : BWMRI

Priority : 1

Plan/Exp. 1.5.6 : **Double haploid in wheat blast breeding**

Objective(s) :

1. To achieve homozygous pure line in one generation compared to 6 to 7 generations required by the traditional system of breeding.
2. To develop wheat varieties, particularly blast resistant varieties very quickly, in 5 to 6 years, compared to more than 8 years required by the traditional methods.
3. To use doubled haploids in basic important genetic studies.

Rationale : Traditional breeding techniques require 6 to 7 generations of inbreeding to stabilize desired yield, quality, disease resistance and other agronomic traits. On the other hand, doubled haploid technique, also known as speed breeding, allows wheat breeders to stabilize the desired traits in a single generation (10 months) and thus reduces variety development time by up to 5 years. This technique also reduces the volume of breeding works by many folds. It requires only 200 DH lines per cross at the initial stage of breeding, compared to around 4,000 F2 lines by the traditional system. Doubled haploids have also been extensively used in genetic studies, including gene/QTL mapping and GWAS.

The University of Sydney Plant Breeding Institute developed a highly successful DH technique, which has already produced and released as many as 10 wheat varieties for commercial cultivation. Most of the wheat breeding programs now use this technique in Australia. It is therefore, justified to undertake research work on this technique, which should

enable wheat breeders to produce varieties very quickly, particularly when a new disease poses a threat to wheat production.

Materials and Methods	**:**	Ten F1 hybrids will be used as experimental materials. Major steps to be followed: ➢ Crossing between F_1 wheat ovary x maize pollen ➢ Application of growth hormone (2,4-D) to enhance embryo growth ➢ Embryo rescue ➢ Regeneration of haploids through tissue culture ➢ Application of colchicine to haploid plants for chromosome doubling ➢ Production of doubled haploids
Investigators	**:**	MM Rahman, F Amin, MA Hakim, G Faruq (Bangladesh), NU Ahmed and R Trethowan (The University of Sydney, Australia)
Season	**:**	Rabi, 2019-20
Date of Initiation	**:**	Oct, 2019
Date of completion		June, 2020
Exp. Output/Benefit	**:**	100% homozygous DH lines will be achieved 100 % homozygous very quickly
Locations	**:**	RBWMRI, BWMRI, Rajshahi
Status	**:**	New
Estimated Cost	**:**	Tk. 20,00,000/-
Source of Fund	**:**	BMWRI/BARC
Priority	**:**	1

Plan/Expt 1.5.7	**:**	**Evaluation of selected blast resistant line in PPP**
Objective(s)	**:**	To select blast resistant/tolerant lines for utilizing in BWMRI breeding programme.
Materials and methods	**:**	Three hundred wheat lines selected from 17 international nurseries planted in PPP, 2018-19. These lines will be further evaluated in PPP for blast resistance.
Crop/variety	**:**	Selected wheat lines with BARI Gom 33, WMRI Gom 3 and BARI Gom 26 as check
Design	**:**	N/A
i. Treatment	**:**	Wheat varieties/lines
ii. Replication & Plot size	**:**	2
Planting system/spacing	**:**	1m 2rows plot
Fertilizer dose and methods of application	**:**	As per BARC recommendation.
Irrigated/rainfed	**:**	N/A
Data to be recorded	**:**	Heading, plant height and blast incidence and severity
Investigators	**:**	MR Kabir, MR Islam, Babul Anwar, KK Roy, R Begum, T Roy

Season	**:**	2020-21
Date of Initiation	**:**	December 2020
Date of completion		April, 2021
Exp. Output/Benefit	**:**	Blast resistance/tolerance wheat lines
Locations	**:**	BWMRI, Jashore
Status	**:**	New
Estimated Cost	**:**	Tk. 500,000/-
Source of Fund	**:**	BWMRI, Jashore
Priority	**:**	1

SUB-PROJECT 1.6: COLLABORATIVE STUDIES WITH INTERNATIONAL ORGANIZATIONS

Germplasm exchange programme between BWMRI and international organizations is established as a part of collaborative study. The materials are mainly received from CIMMYT, Mexico; Nepal and other countries. Materials are being developed in Bangladesh are also being sent to different institutions to test their performance and future use in their programme. The following international experiments are expected to be conducted this year (2019-20).

Name of the experiment	Seeding time	Source	Experimental locations	Investigators
A Bread Wheat				
1.6.1 41st ESWYT (1 set)	ITS	CIMMYT	Dinajpur	MM Hossain and MA Hakim,
1.6.2. 53rd IBWSN (1 set)	ITS	CIMMYT	Dinajpur	MM Hossain, MA Hakim
1.6.3. 19th HTWYT (3 sets)	ILS	CIMMYT	Din, Joy and Jas	MR Kabir, MF Amin, MR Islam
1.6.4. 28th SAWYT (1 set)	RTS	CIMMYT	Rajshahi	MAA Mamun, AA Khan,
1.6.5. 38th SAWSN (1 set)	RTS	CIMMYT	Rajshahi	MAA Khan, Y Abida
1.6.6. 9th WYCYT (3 sets)	ITS	CIMMYT	Raj, Din, Joy	Y Abida, MF Amin, MA Hakim,
1.6.7 3rd CWYT	ITS	CIMMYT	Din	MSN Mandal, MR Kabir, MA Hakim
1.6.8. 10th SATYN (3 sets)	RTS	CIMMYT	Joy, Din, Raj	MAA Khan, G Faruq, MA Hakim,
1.6.9 11th HPYT (3 sets)	ITS	CIMMYT	Joy, Din	MSN Mandal , MM Hossain, MA Hakim, MM Rahman, MF Amin
1.6.10 12th HPAN	ITS	CIMMYT	Din	MSN Mandal, MA Alam, MM Hossain
1.6.11 20th SABWGPYT (10 sets)	ILS	CIMMYT	Jam, Din, Jas	MM Rahman, MA Alam
1.6.12 28th HRWYT	ITS	CIMMYT	Din	MN Alam, MR Kabir, MA Alam
B. Durum Wheat				
1.6.13 52nd IDYN	ITS	CIMMYT	Dinajpur	MN Alam and MM Hossain
Total cost = Tk.12,00,000/-				

SUB-PROJECT 1.7	**:**	**BIO-FORTIFICATION IN WHEAT**
Plan/Exp. 1.7.1	**:**	**6th Zinc-enrich wheat yield trial (6th ZnWYT)**
Objective(s)	**:**	To evaluate the potentiality of developing bio-fortified wheat line(s) & to identify promising genotypes with higher levels of Zinc content
Rationale	**:**	Zinc and Fe deficiencies are a growing public health and socio- economic issue, particularly in the developing world. Recent reports indicate that nearly 500,000 children under 5 years of age die annually because of Zn and Fe deficiencies (Black *et al.* 2008). In South Asia, more than 26 per cent of the population is Zn deficient due to low dietary intake of Zn and Fe. Genetic biofortification to improve Zn and Fe concentrations in major staples including bread wheat (*Triticum aestivum* L.) could greatly reduce micronutrient malnutrition. Development of genetically enriched wheat varieties through breeding is considered as a promising and cost-effective approach for diminishing malnutrition problem. Recently CGIAR initiated program on biofortification of staple crops to develop crop varieties with high micronutrient contents. Under this initiative CIMMYT is developing high yielding bread wheat genotypes with enhanced levels of Zn and Fe primarily targeting people of South-East Asian countries. Bio-fortification has been defined as the process of increasing bio-available concentrations of essential elements in edible portion of crop plants through genetic selection or agronomic interventions. Bio-fortification of wheat is viable as adequate genetic variation for Zn (25-56 mg/kg; average 37mg/kg) and Fe (25-65 mg/kg; average 35 mg/kg) is being reported in the wheat gene pool which allows selection of nutritionally improved breeding materials. By combining the high micronutrient density trait with high yield is possible to develop high yielding wheat with enhanced Zn and Fe concentrations. This program will help to identify wheat genotypes with enhanced levels of Zn and Fe content which will facilitate future breeding program to develop bio-fortified wheat variety.
Materials and methods	**:**	Twenty-five selected entries from 6th HPYT & 7th HPAN including a check
Crop/variety	**:**	Wheat
Design	**:**	5 X 5 alpha lattice, 2 replications
Treatment	**:**	Selected lines will be sown in irrigated timely sown (ITS) and irrigated late sown (ILS) condition
Plot size	**:**	5m x 8 rows
Planting system/spacing	**:**	20 cm spacing between rows
Fertilizer dose	**:**	As per recommendation
Irrigated/rainfed	**:**	Irrigated
Investigators	**:**	MM Hossain, MA Alam and MA Hakim
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	November 2020

Exp.Output/Benefit	**:**	High micronutrient (Zn) density wheat germplasm will be identified which will be further evaluated in the next season for releasing as new variety and/or will be used in future breeding program.
Location	**:**	Dinajpur, Joydebpur, Jamalpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,00,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

SUB-PROJECT 1.8: PARTICIPATORY VARIETY SELECTION (PVS)

Scientists are developing good number of varieties, but many of those are not being adopted by the farmers in expected rate. Some of the major causes of low adoption may be lack of knowledge about the varieties due to inadequate extension activities, improper selection situation (i.e well fertilized and good management conditions) that does not match well with the most farmers' growing conditions, lack of specifically adapted varieties etc. By this time participatory variety selection (PVS) and participatory plant breeding (PPB) were found to be very effective in addressing many of those problems. Moreover, PVS farmers grow the crop by their own management in their agro-economic conditions and select the varieties according to their socio-economic needs. Participatory research could be very useful to identify farmers'-preferred new varieties and thereby overcome the constraints that cause farmers to grow land races, old or obsolete varieties. Moreover, participatory research increases the job efficiency of the scientists and farmers' knowledge that enables seeds to be retained effectively from year to year and encourages the poor to refrain from buying seeds each year. Research costs can be reduced, and adoption rates increase if farmers are allowed to participate in variety testing and selection process (Joshi, et al., 1995). In-addition, production increases when farmers adopt new varieties identified through participatory research. PVS is a research and extension approach. Seed dissemination through farmers to farmers is more rapid than conventional approach through BADC. In this method about 5 years is needed to start seed delivery to the farmers after release of a new variety. By this time many varieties may start degenerating.

Plan/Expt 1.8.1	**:**	**PVS: Mother and baby trials and informal seed dissemination**
Objective(s)	**:**	1. Demonstrating the performance of the rust resistant promising advanced lines and new varieties to the farmers under their own management conditions. 2. Providing scope to the farmers for selecting the varieties/lines suitable for their own socio-economic conditions. 3. Exploit G x E interaction by growing genotypes in diverse production environments to increase selection efficiency 4. Enhancing seed production and dissemination at farmers' level.
Rationale	**:**	All new wheat varieties are not disseminating rapidly in Bangladesh like many other countries and old varieties are occupying vast areas despite, good technology transfer activities. Literature revealed that inadequate extension effort, lack of specifically adapted varieties, improper selection/screening situation in conventional plant breeding and some other causes may be responsible for poor adoption. By this time participatory variety selection (PVS)-mother and baby trials has been found to be very effective to overcome many of those problems. So, conducting PVS-mother and baby trials in farmers' fields for selection, as well as, seed production and dissemination of new of varieties by farmers are very important.

Materials and methods	:	Eight genotypes (2 varieties and 6 advance lines) will be grown in mother trials (MT) at farmers' fields of Thakurgaon, Rajshahi, Jashore, Jamalpur and Tangail. There will be one village in all locations. There will be two sets of the trial in each village, which will be treated as dispersed replication. Unit plot size for each genotype will be 20m2. Fertilizers and seeds will be supplied to the farmers. Other managements will be used as farmers' practices of the respected areas to raise the crop. Scientists of BWMRI and DAE personnel will supervise the experiments. A focus group discussion (FGD) will be organized before seeding, where farmers, as well as, village coordinators will be selected, and seeds will be distributed. Variety evaluation will be organized two times; one at physiological maturity and the other at post harvest stages to collect farmers' preference scores about the genotypes. Data Collection: Data will be recorded on yield, TGW, heading and maturity, visual sterility and farmers' preference scores about the genotypes for different characters and overall preference etc. Farmers and scientist's preference scores from each MT will be taken on: height, maturity, tillering, disease infection, spike length, expected yield and overall preference (at physiological maturity stage), grain yield, grain physical characteristics (size, colour etc.), black point in seed and overall preference score (at post harvest stage). The data within location will be analyzed in RCBD considering each MT as dispersed replication and that of over locations by RCBD one factor combined over locations. Baby Trial Three advanced lines will be tested in baby trial (BT) with BARI Gom 28 at 2 farmers' fields per village. So, in total, there will be 06 BT per village per location. Only 1 kg seed per advanced genotype and 1kg seed of BARI Gom 28 will be supplied to each farmer. After harvest, a house hold level questionnaire (HLQ) will be supplied to evaluate the genotypes of BT. Yield data will be taken from farmers and compared by paired t-test.
Investigators	:	MA Alam, MSN Mandal, MM Hossain, MA Hakim — Dinajpur MAA Mamun, MM Rahman, and AA Khan — Rajshahi MR Islam — Jashore
Season	:	Rabi 2020-21
Date of Initiation	:	November 2020
Exp. Output/Benefit	:	Farmers will be able to select varieties and advance lines according to their socio-economic needs.
Locations	:	Dinajpur, Jashore, Rajshahi
Status	:	On-going
Estimated Cost	:	Tk. 1,50,000/- (50,000/- per village/location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1
Remarks	:	Farmers-preferred varieties will be identified

SUB-PROJECT 1.9	**:**	**DEVELOPMENT OF DURUM AND TRITICALE VARIETY**
Plan/Expt 1.9.1	**:**	**Durum Yield Trial (DYT)**
Objective(s)	**:**	1. Selection of promising durum lines for higher grain yield 2. Advancing promising durum lines for further improvement
Rationale	**:**	Durum wheat has strong gluten content although its life span is relatively longer as compared to bread wheat. Due to its strong gluten content and other industrial quality it is extensively used for commercial production of noodles, pasta, spagati and macaroni. In Bangladesh consumption of these food products are increasing day by day. There are some food industries in Bangladesh which are producing these food items by importing durum wheat from abroad. There is a good potentiality to grow durum wheat in cooler northern parts of Bangladesh which can be eventually be used in producing these food items. Therefore, the present study was undertaken to evaluate and select promising durum lines for releasing them as variety.
Materials and methods	**:**	9 genotypes selected from IDYN (2018-19) and DYT (2018-19) plus Morocco 2 and BDW-8 as checks will be included in this trial. Each entry will be grown in 5m long 6rows with row spacing of 20cm keeping 60cm between entries in 4x7 alpha-latice design with 3 replications. Fertilizer will be applied @ 100-30-50-20 NPKS kg/ha. Two-third of N and all others fertilizes will be applied as basal before final land preparation. Rest one-third of N will be top dressed at CRI stage with light irrigation. Recommended managements will be followed to raise the crop. Data will be recorded on days to heading, maturity, plant height, grains/spike, diseases, 1000-grain weight and yield.
Investigators	**:**	MN Alam, MSN Mandal, MM Hossain
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	November 2020
Exp. Output/Benefit	**:**	Suitable genotypes will be identified for adaptive trial
Locations	**:**	BWMRI, Dinajpur
Status		On-going
Estimated Cost	**:**	Tk. 20,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1
Plan/Expt 1.9.2	**:**	**Triticale Yield Trial (TYT)**
Objective(s)	**:**	1. To identify genotypes with good adaptation 2. Selecting promising triticale lines for both forage and grain
Rationale		Triticale is called man made cereal which is evolved from crossing of wheat and rye. It is used both for forage and grain purposes. In Bangladesh there is scarcity for forage for dairy cattle. Triticale grain can largely be used as poultry and fish feed. Its flour which has high protein content can be mixed up with wheat flour for human consumption. Triticale has a good potentiality to be used as forage for cattle and grain in poultry industry. So, the present study has been undertaken to evaluate and select triticale lines with high forage and grain yield potentiality.
Materials and methods	**:**	Two genotypes selected from TYT (2018-19) along with BARI Triticale-1, BARI Triticale-2 as checks will be included in the trial. Each entry will be

grown in 5m long 8 rows with row spacing of 20cm keeping 60cm between entries. The experiment will be planted in RCB design with 3 replications. Fertilizer will be applied @ 120-30-50-20 NPKS kg/ha. Half of N and all others fertilizes as basal dose before final land preparation. One-fourth of N as first top dress at CRI stage with irrigation.

Data collection: Data will be recorded on days to heading, maturity, plant height, disease reaction, grain weight, green biomass at 40 DAS, grain yield.

Investigators : MN Alam, MSN Mandal, MM Hossain

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Suitable genotypes will be identified for Advanced Yield Trial

Locations : BWMRI, Dinajpur

Status : On-going

Estimated Cost : Tk. 25,000/-

Source of Fund : BWMRI, Dinajpur

Priority : 1

SUB-PROJECT 1.10 : **VARIETY MAINTENANCE AND BREEDER SEED PRODUCTION**

Plan/Expt 1.10.1 : **Maintenance of first and second year lines of recommended varieties**

Objective(s) :
1. To maintain purity of nucleus seeds of newly released varieties
2. To produce pure seeds for breeder seed production

Rationale : The maintenance purity of a variety is important for nucleus seed stock of varieties required for future demand to produce breeder seed. It is also necessary to carry out initial purification of new varieties/candidate varieties to meet up requirements for varietal distinctness, uniformity and stability, and establish their characteristics before release. The variety maintenance is a procedure to be used for varietal purification. Purified seed will be used to produce healthy seed for breeder seed production.

Materials and methods :

1st year line

Varieties : BARI Gom 26, 28, 30, 32, 33, WMRI Gom 1, 2 &3

Unit plot size : 5m long single row, No. of seeds/plot : 100

BARI Gom 30, 32, 33 and WMRI 1 will be planted by hand in 200 rows while rest varieties will be planted by hand in 100 rows. It is noted that from the 200 rows 50 uniform rows will be selected and from the 100 rows 25 uniform rows will be selected. From each selected lines 5 single plants will be uprooted as a stock for next year's 1st yr line. The selected 50/25 rows will be harvested separately as a stock of next year's 2nd year line.

2nd year line

Varieties : BA RI Gom 30, 31, 32 and 33

Unit plot size: 6 rows 11m long with 2 replications. Plot of BARI Gom 30, 32 and 33 will be 100. The 2nd year plots will be planted around the 1st year lines. A system of record keeping will be maintained so that the family relationship between 1st and 2nd year plots is identified.

Data to be recorded on grain yield and disease reaction

Investigators : MSN Mandal and all wheat breeders

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Seed stock will be used in breeder seed production

Locations : BWMRI, Dinajpur

Status : On-going

Estimated Cost : Tk. 2,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt. 1.10.2 : **Breeder seed production of recommended wheat varieties**

Objective(s) : To produce breeder seed for BADC and private enterprises.

Rationale : To maintain the purity of a variety, a regular supply of breeder seeds to BADC/NGO and registered growers is needed for production of quality seeds as foundation stock which in turn produces certified seeds. Breeder seed of commercially cultivated varieties is regularly supplied to the concerned organizations. Breeder seed is genetically pure and free from admixture with other crops and varieties. This pure seed is used for production of good quality seed.

Materials and methods : Varieties: BARI Gom 30, BARI Gom 31, BARI Gom 32, & BARI Gom 33. WMRI Gom 1, 2 and 3
Area: 25 ha
Seed rate : 100 kg/ha
Fertilizer dose : 100 : 30 : 50 : 20 NPKS kg/ha
Time of sowing : Nov. 20-30 (optimum)
Irrigation : 3 (at CRI, Booting, Grain filling stage)
Data to be recorded on grain yield and diseases

Investigators : MN Alam, MSN Mandal, MM Hossain and MI Hossain, MAA Khan (Raj)

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Pure and quality seed will help for increased wheat production

Exp. Output/Benefit : Pure and quality seed will help for increased wheat production

Locations :

Location	Variety	Land area (ha)
WRSS, Debiganj	BARI Gom 30	3.5
	BARI Gom 32	3.5
	BARI Gom 33	6
WRSS, Thakurgaon	BARI Gom 33	2.5
RBWMRI, Rajshahi	BARI Gom 33	1.75
BWMRI, Dinajpur	BARI Gom 32	1.5
	BARI Gom 30	1
	WMRI Gom 1	0.5
	WMRI Gom 1	0.5
	WMRI Gom 1	0.5
Total		21.25

Status	**:**	On-going
Estimated Cost	**:**	Tk. 44,00,000/- (2,00,000/- per hectare)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Experiment 1.10.3	**:**	**Multiplication of pre-released wheat varieties**
Objective(s)	**:**	1. produce good quality seeds for using in up-scaling 2. multiply seeds of pre-release varieties for quick dissemination soon after release 3. quick replacement of old varieties
Rationale	**:**	Wheat is the second most important cereal crop in Bangladesh and the availability of rust resistant, higher -yielding wheat varieties is essential to Bangladesh food security. Rapid multiplication and dissemination of resistant seed in Bangladesh has tremendous impact on improving wheat productivity. One key factor is the multiplication of promising pre-released lines, rather than waiting until they were approved for varieties, a much longer process. Also key was growing the lines in multiple, scattered locations, rather than a centralized location through participatory variety selection and seed multiplication. So, farmers could readily see the benefit of adopting the new lines. Moreover, this seed could be utilized for up-scaling the seed to the farmers through variety demonstration.
Materials and methods	**:**	Materials: Advanced wheat lines Seed rate -100 kg/ha Irrigation - 3 (at CRI, Booting and Grain filling stages) Planting method - machine planting
Investigators	**:**	MN Alam, MM Hossain, MA Alam, MSN Mandal, MA Hakim,
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	November 2020
Exp. Output/Benefit	**:**	One ton seed of each candidate varieties will be available just after official release
Locations	**:**	Dinajpur
Estimated Cost	**:**	Tk 1,00,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt. 1.10.4	**:**	**Seed increase of recommended varieties and the lines included in the nurseries and trials of wheat, triticale and durum**
Objective(s)	**:**	To produce good quality seeds for use in the nurseries/ yield trials for next year experiments and demonstrations.
Rationale	**:**	For growing next year's experiment and demonstration we need to have pure seeds. For that reason, seed production programme was developed.
Materials and methods	**:**	Materials: Recommended varieties and advance lines Seed rate 100 kg/ha Irrigation 3 (at CRI, Booting and Grain filling stages)

Planting method machine planting.
Data to be recorded on disease infection, sterility etc.

Investigators : MA Hakim, MR Kabir, MM Hossain, MM Bazzaz, MI Hossain, MSN Mandal, G. Faruq, MM Rahman, MA Ali, MR Islam, MM Hossain, M Asaduzzaman, MM Rahman, MA Zaman.

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Pure seed production for the next year

Locations :

Location	Variety	Land area (ha)
Dinajpur	BARI Gom 25, 28, 29, 30, 31, 32 & 33, Advanced wheat lines, durum & triticale	06
Debiganj	BARI Gom 28, 29 & 30	01
Rajshahi	BARI Gom 30	02
Joydebpur	BARI Gom 25, 28 & 30	03
Jamalpur	BARI Gom 28 & 30	03
	Total	15

Status : On-going

Estimated Cost : Tk 30,00,000/- (Tk. 2,00,000/- per ha)

Source of Fund : BWMRI, Dinajpur

Priority : 1

B. SPECIAL PROGRAMME

PROJECT 1: VARIETY DEVELOPMENT

SUB-PROJECT 1.11: DEVELOPMENT OF SALINITY TOLERANT VARIETY

There are huge lands remain unexploited in semi-saline coastal areas of southern Bangladesh after harvest of T Aman. Out of 2.85 million hectares of the coastal and offshore areas about 0.83 million hectares are arable lands. This is 30% of the total arable land. If, wheat breeders can select wheat varieties suitable for these lands, a vast area will be possible to bring under wheat cultivation. Therefore, this sub-project for development of salinity tolerant variety was initiated.

Plan/Exp. 1.11.1	**:**	**Wheat variety/line screening in saline area**
Objective(s)	**:**	1. Select the suitable wheat varieties/lines for saline areas 2. Identify and select sources of resistance.
Rationale	**:**	A vast potential agricultural land in the coastal belt of Bangladesh remains fallow in Rabi season. Fallow land in southern Bangladesh during winter was estimated to be more than 400,000ha which is suitable for growing wheat (Rawson et. al. 2011). High yielding, heat tolerant wheat variety having moderate level of tolerance to salinity could be adapted in this area to increase the volume of domestic wheat basket. Earlier studies showed that the salinity level in those areas ranges from 2 to beyond 20 dS/m from November to March. Generally, it was observed that salinity level increased with the increase of soil dryness. Wheat can be grown in the semi saline belt but for successful cultivation, it needs to identify suitable variety/genotypes capable to avoid/tolerate the salinity
Materials and methods	**:**	Eight genotypes selected from last years' trial along with 6 varieties will be included in this trial. The experiment will be conducted in RCBD design with 4 replications in the farmers' field of Shatkhira and Patuakhali. Plot size will be 2.5m long 4 rows with 20 cm spacing. Fertilizer will be applied as per recommendation. **Data to be recorded:** Data will be recorded on soil salinity at sowing and 15 days interval, climatic data, initial plant population, days to heading, maturity, plant height, biomass, spikes per sq. meter, 1000-grain weight, grains/spike, grain yield, disease reaction, visual sterility, physical grain quality etc.
Investigators	**:**	MM Hasan, MM Rahman, MA Rahman (Shatkhira), SI Khan (Patuakhali)
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	2016
Exp. Output/Benefit	**:**	Farmers will be able to grow suitable wheat varieties for saline areas of Coastal area
Locations	**:**	Patuakhali, Shatkhira (On-station and farmer's field)
Status	**:**	3rd year
Estimated Cost	**:**	Tk. 1,00,000/-(Tk. 50,000/each location)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Exp. 1.11.2 : **Screening of wheat genotypes in the saline soil of Bangladesh**

Objective(s) :
1. To screen wheat genotypes in the salinity condition
2. Identify and select salt tolerant genotypes based on the morpho-physiological traits

Rationale : Many potential agricultural lands in the coastal belt of Bangladesh remain as fallow land in the Rabi season. The previous studies exhibits that the salinity level in those areas ranges from 2.0 to 20 dSm^{-1} from November to March. Generally it is observed that salinity level is increased with the increase of soil dryness. Wheat can be grown in the saline belt. But it needs to develop suitable variety/genotype/line which can be grown in the saline regions during rabi season.

Materials and methods : Twenty genotypes will be included in the study for screening against salinity in the field condition. Before seed sowing, the salinity level of the experimental field will be estimated. The seed will be sown in line in 20 cm apart, and 2-3 cm soil depth. Crop management will be performed as the guidelines of BWMRI. The experiment will be laid out in RCBD with three replications.

Data to be recorded:

The data will be recorded:

i. Seed germination rate (count the seedlings at 3, 5, 7, 9, 11, 13 DAS)
ii. Survival rate (count the seedlings at 5, 10, 15, 20, 25, 30 DAS)
iii. Chlorophyll content
iv. POD, SOD, CAT
v. Number of tiller (count the tillers at 10, 20, 30, 40, 50, 60 DAS)
vi. Leaf area
vii. Yield and yield contributing characters
viii. Shoot and Root Dry weight (plant materials were dried at $70^{O}C$ for 72 hours in the electrical oven)

The Salt tolerance index will be calculated by the formula given below:

Stress (Salt) tolerance index (STI) = $\frac{Ys}{Yc}$ (Fischer and Maurer, 1978)

Where S= salinity of 16 dSm^{-1} and C= Control

Investigators : MM Hossain, MN Alam, MA Hakim, G. Faruq, MA Alam, MSN Mandal, MR Kabir, R Islam, MH Rashid-OFRD, Khulna; MM Rahman-OFRD, Patuakhali

Season : Rabi 2020-21

Date of Initiation : 2020

Exp. Output/Benefit : Salt tolerant wheat variety (s) or genotype (s) will be found out.

Locations : Dacope-Khulna; Patuakhali

Status : 1st year

Estimated Cost : 350,000/-

Source of Fund : BWMRI

Priority : 1

SUB-PROJECT 1.12: DEVELOPMENT OF STRESS TOLERANT VARIETY

There are many lands remaining uncultivated in the *rabi* season in Bangladesh after of T. *Aman* rice harvest due to unavailable soil moisture. Drought tolerant wheat variety may be the promising crop to bring the areas under cultivation. To develop drought tolerant wheat variety, the experiments will be conducted under water deficit condition followed by wheat genotypes screening techniques and selection methods based on the physio-morphological traits.

Plan/Exp. 1.12.1 : **Molecular characterization of bread wheat (*Triticum aestivum* L.) germplasm for drought tolerance using SSR markers**

Objective(s) :
1. To screen wheat genotypes in the drought condition
2. Identify and select salt tolerant genotypes based on the physio-morphological traits

Rationale : Water deficiency in the land or crop land is called drought or drought is defined as the deficiency available moisture in the land for growing crop. Drought stress is one of the abiotic stresses threating to plants phenotypic, physiological and genetical expressions (Bi *et al*. 2016; Antoniou *et al*. 2017). The plants are sessile organism and have to challenge to adverse environmental conditions in order to minimize detrimental effects on plant growth and development (Barkla *et al*. 2013). Environmental stress factors including drought, cold, heat, salinity, heavy metals, ultra-violet ray and water logging are intensified day after day due to global warming effects and climate change which have become the great threats to crop production, sustainable agriculture and global food security (Cheeseman 2016). In response to abiotic stresses, plants develop complex signaling pathways to activate downstream stress responsive genes. Functions of these genes have been well characterized, and biotechnology approaches have been developed to improve plant stress tolerance through genetic manipulation of these genes (Moshelion and Altman 2013). Now a day, the usage of SSR (single repeat sequence) marker is the important tool to screen drought tolerant genotype grown under drought stress. TC149903, Xwmc89, Xwmc420, Xgwm601, BE637912, CA487065b, CA487065a, markers are found around the identified QTL position on chromosome 4A for breed wheat (*Triticum aestivum*). The QTL for grain yield is associated with three markers, BE637912, Xwmc89, and Xwmc420. QTL for spike density is associated with marker Xwmc89. QTL for grain m^{-2} is found associated with Xwmc89 and Xwmc420. Grain filling rate and biomass production rate are significantly associated with marker loci; Xwmc601, Xwmc89, and Xwmc420. DSI QTLs associated with Xgwm601 and BE637912 responsible for phenotypic variation, respectively. To screen drought tolerant line/genotype, the experiment will be conducted with water deficit stress condition.

Materials and methods : TC149903, Xwmc89, Xwmc420, Xgwm601, BE637912, CA487065b, CA487065a will be used for the experiments to screen drought tolerant line/genotype. Eighteen genotypes will be included in the study for screening against drought in the field condition. Before seed sowing, the soil moisture level of the experimental field will be estimated. The seed will be sown in line in 20 cm apart, and 2-3 cm soil depth. Crop management will be performed as the guidelines of BWMRI. The experiment will be laid out in RCBD with three replications.

Data to be recorded:

The data will be recorded:

i. Seed germination rate (count the seedlings at 5, 7, 9, 11, 13 DAS)

ii. Survival rate (count the seedlings at 5, 10, 15, 20, 25 DAS)
iii. Chlorophyll content
iv. Electrolyte leakage (EL)
v. POD, SOD, CAT
vi. Number of tiller (count the tillers at 15, 45, 60 DAS)
vii. Leaf area (count the tillers at 15, 45, 60 DAS)
viii. Yield and yield contributing characters
ix. Shoot and Root Dry weight (plant materials were dried at 70^{O}C for 72 hours in the electrical oven)

The Salt tolerance index will be calculated by the formula given below:

Stress (Salt) tolerance index (STI) = $\frac{Ys}{Yc}$ (Fischer and Maurer, 1978)

Where S= salinity of 16 dSm^{-1} and C= Control

Investigators : MN Alam, MM Hossain, MA Hakim, G. Faruq, MSN Mandal, MR Kabir, MA Alam, MAA Khan, MM Rahman

Season : Rabi 2020-21

Date of Initiation : 2020

Exp. Output/Benefit : Drought wheat variety (s) or genotype (s) will be found out.

Locations : Dinajpur, RC, Rajshahi

Status : 1st year

Estimated Cost : 400,000/-

Source of Fund : BWMRI

Priority : 1

Plan/Expt 1.12.2 : **Screening of advanced wheat genotype under hawar area in Habigang district**

Objective(s) :
1. Evaluating yield potential of the advance lines under hawar area
2. Selecting promising lines for evaluation in Candidate Variety Demonstration

Rationale : A vast crop growing area after aman rice remain fellow in hawar area during winter season. Wheat has a scope to grown in that area. Suitable wheat variety can be cover a considerable area of this fellow land in rabi season. Therefore New varieties need to be developed that can withstand adverse climatic condition in hawar area, particularly the soil moisture stress in order to produce satisfactory yield per unit area. Therefore advanced lines selected from different trials will be tested under hawar area to observer their potentiality. .

Materials and methods : Ten advance lines selected from PYT /AYT(2019-20) along with BARI Gom 32 and WMRI Gom 1 will be tested in this trial in optimum seeding (ITS) conditions. Promising lines will be selected on the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality for next trial. Crop management practices will be as per recommendation of BWMRI.

Crop/variety : Selected wheat lines

Design : Alpha lattice

Treatment	**:**	10 promising wheat genotypes and 2 checks
Replication	**:**	2
Plot size	**:**	5 m long X 20 rows
Planting system/spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated
Data to be recorded		Data will be recorded on days to heading, maturity, plant height, visual sterility, disease reactions, TGW, grain yield and visual grain quality etc. under optimum and late seeding conditions.
Investigators	**:**	MM Rahman, MM Khan, MA Hakim, MG Faruq and M Bodruzzaman
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	Irrigated timely seeding (ITS)- 20-25 Nov, 2020, Irrigated late seeding (ILS)- 20-25 Dec 2019 and
Date of Completion		April 2021
Exp. Output/Benefit	**:**	Will help to select suitable genotypes for candidate variety demonstration
Locations	**:**	Dinajpur (Exp + SM), Joydebpur, Jashore, Jamalpur, and Rajshahi
Status	**:**	On-going
Estimated Cost	**:**	Tk. 5,00,000/- (Tk. 75,000/- for each set and 50,000/- for SM)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Exp. 1.12.3.	**:**	**Identifying of genotypic potentiality of wheat and maize in non-traditional daily use**
Objective(s)	**:**	1. To identify superior wheat and maize genotypes for nontraditional uses 2. To develop technology based on wheat and maize in minor agro industries
Rationale	**:**	In Bangladesh, wheat and maize are commonly using for daily human consumption and poultry industry. However, there are good prospect for using these crops in minor agro industries. For instance, hydroponic fodder cultivation, Flour of wheat maize mixtures etc. Extensive use of these crops might be a good indicator of increasing crop areas. However, genotype / variety specific use is needed and for that it is compulsory to identify the distinct superior variety/ genotype
Materials and methods	**:**	Plant Materials: Thirty 30 high biomass content wheat / triticale (15) and Maize (15) genotypes

Methods:

A Thirty (30) days short Bench mark survey will be conducted to know the real scenario and demand of the end users. And then the production technique will be optimized. Initially, two technique will be considered.

1.
   a. Optimization of maximum Hydroponic fodder production technique in 2 weeks
   b. Screening of different wheat and maize genotypes following the optimized hydroponic technic
2.
   a. Estimation of commercially viable wheat and maize mixture
   b. Identifying wheat and maize genotype for the estimated viable mixture

A suitable experimental design will be adopted after benchmark study

Investigators	**:**	MM Rahman, A. Hakim, G Faruq, M. Bodruzzaman
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	2020
Exp. Output/Benefit	**:**	genotypic specific potential technology will be innovated for nontraditional wheat and maize use
Locations	**:**	Gazipur and Dinajpur
Status	**:**	1st year
Estimated Cost	**:**	500,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

Plan/Exp. 1.12.4	**:**	**Analysis of various components of recent released varieties and advanced lines of wheat**
Objective(s)	**:**	1. To know the compositions of various lines needed for health friendly safe and secure varieties released 2. To assist stress tolerant and nutrient-enriched variety improvement
Rationale	**:**	Wheat is the first stable food of the world people; rice and potato are second third stable food, respectively. Generally wheat contains 12-14% protein, and 6-7% carbohydrate. It also contains fat, vitamins and minerals more than rice. In a ward, wheat is very rich in protein, CHO, fat. Vitamins and minerals. All kinds of bread wheat don't contain same composition of all these food components. Before a release variety, the analysis of necessary components of lines/entry/advanced line of wheat is crucial task which will help us to develop a vitamin, minerals and other elements rich variety.

Materials and methods : **Data to be recorded:**

The data will be recorded:

A. Variety: BARI Gom 30, BARI Gom 31, BARI Gom 33, WMRI Gom 1, WMRI Gom 2, WMRI Gom 3
B. Advanced line: Nine advanced lines

The components will be analysis:

I. Total Protein, Glutenin, Gliadin, Albumin, Globulin, Damaged starch, Fiber, Fat, Ash;
II. Vitamin B complex (Thiamin-B1, Riboflavin-B2, Niacin-B3), Vitamin C, Vitamin D, Phenolic compounds, Enzyme Activity, α-Amylase Activity, Proteolytic Activity;
III. Total nitrogen, Soluble nitrogen, P, Zn, Fe, Ca, Mg, Al

Investigators	:	MN Alam, MR Kabir, MA Alam, MSN Mandal, MA Hakim, G. Faruq,
Season	:	Rabi 2020-21
Date of Initiation	:	2020
Exp. Output/Benefit	:	Drought wheat variety (s) or genotype (s) will be found out.
Locations	:	Dinajpur
Status	:	1st year
Estimated Cost	:	400,000/-
Source of Fund	:	BWMRI
Priority	:	1

PROJECT 2: MAIZE IMPROVEMENT

Major objectives :

- ❖ Develop source population and elite inbred lines of maize
- ❖ Development of medium stature and high yielding normal field corn hybrids;
- ❖ Development of good quality high yielding hybrids of popcorn, sweet corn and baby corn;
- ❖ Development of high yielding biofortified maize(PVA, QPM etc)*;*
- ❖ Development of stress tolerant hybrids (drought, heat, salt and excess soil moisture)
- ❖ Emphasis on seed production of *parental lines and hybrids through GO and NGOs; and*
- ❖ Dissemination and popularization of developed technologies
- ❖ among farmers and private agencies

SUB PROJECT 2.1: GERMPLASM COLLECTION AND MAINTENANCE

Programme	:	Wheat and Maize Improvement
Project	:	Maize Improvement
Sub Project 2.1	:	Germplasm Collection and Maintenance
Experiment 2.1.1	:	**Maintenance and characterization of locally developed inbred lines of maize (8 sets)**
Objective(s)	:	To characterize and maintain newly developed inbred lines
Rationale	:	BARI/BWMRI has developed more than 100 inbred lines derived from commercial hybrids. For future breeding program, it is necessary to characterize those inbred lines.
Materials and methods	:	Set I : EDW (50 lines) - Early and dwarf line -Field corn Set II : HYG (15 lines) - Medium height and high yield goal -Field corn Set III: American popcorn (20 lines) - Pop corn Set IV: Swiss popcorn (30 lines) - Pop corn Set V : Super Sweet (40 lines) – Sweet corn Set VI : 9120 (27 lines) - Field corn Set VII: Titan (45 lines) - Field corn Set VIII: Multi Parent Synthetic (MPS) Lines (72 lines) - Field corn
Crop/Variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	Single row 4 m long plot
Spacing	:	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigations were applied as and when necessary
Data to be recorded	:	As per CIMMYT maize descriptor
Investigator(s)	:	S.H. Omy and M. Amiruzzaman (Set I); S.S. Alam & M.K.Alam(Set II); S.H.Omy and M. K. Alam (Set III , IV & V); A.N.M.S. Karim (Set VI); A.N.M.S. Karim and M.K. Alam (Set VII) and A.H.Akhi and S. Ahmed(Set VIII)
Season	:	Rabi

Date of initiation		November, 2020
Date of completion		May, 2021
Expected output	**:**	Enough selfed seed of each inbred line would be obtained for breeding purpose.
Locations	**:**	Gazipur
Status of the experiment		New
Estimated cost	**:**	15,000/- per set
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project	**:**	Maize Improvement
Sub Project 2.1	**:**	Germplasm Collection and Maintenance
Experiment 2.1.2	**:**	**Maintenance of exotic inbred lines of maize (2 Sets)**
Objective(s)	**:**	To characterize, maintain and evaluation of newly introduced inbred ..
Rationale	**:**	BWMRI received inbred lines from different international organization and it is necessary to maintain them for future breeding program.
Materials and methods	**:**	Set I: CIMMYT-Zimbabwe (18 lines: Pro-Vitamin A enriched) and Set II: CIMMYT (17 lines: Fall Army worm resistant -9 lines and others-8)
Crop/Variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	Single row 4 m long plot
Spacing	**:**	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigations were applied as and when necessary
Data to be recorded	**:**	As per CIMMYT descriptor
Investigator(s)	**:**	A. Ahmed & M. A. Miah and A.H.Akhi & S. Ahmed
Season	**:**	Rabi
Date of initiation		November, 2020
Date of completion		May, 2021
Expected output	**:**	Enough selfed seed of each inbred line would be obtained for breeding purpose.
Locations	**:**	Dinajpur and Gazipur
Status of the experiment		On-going
Estimated cost	**:**	35,000/- for each location
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.2: DEVELOPMENT OF SOURCE POPULATION AND INBRED LINES

Programme	**:**	Wheat and Maize Improvement
Project	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.1	**:**	**Development of base population in maize**
Objective(s)	**:**	To develop source population for the production of desirable elite/superior inbred lines locally

Rationale	**:**	The source population can be developed through various ways. Plant breeding division also receives many hybrids from abroad through different seed companies. These materials are the important source of valuable gene pool. Through exploiting those genes, a good genetic base can be developed using appropriate breeding techniques. Keeping this in mind, this program has been designed to extract new inbreds from available commercial hybrids as per set objectives.
Materials and methods	**:**	Pool 3: Cycle 1, equal amount of seeds of 55 superior commercial field corn hybrids (Miracle, Mohabir, Mukut, Elros, 9120, Eureka, Rabi, Everest, Orange Gold, Summit, Bumper, Elite, Gourov, Top class, Robust, Sunshine, Palowan, Kaberi 50, Super Gold, Super shine, Dadagiri, Super hit, Boss, Don 111, Kiron, Moon 4081, NH 7720, Hiramon 917, 25K60, Emperor 55, 981, 987K,224, 339, 949, Fortune, Duranta 202, Perfect 30B51, P3350, P3355, P3388, P3396, 30V92, Hiramon 914, Pacific 999 Super, Pacific 139, Pacific 224, Pacific 293, Pacific 984, Pacific 60, Mondol 35B55, Champion 333555, JF 55, Super choice 30B92, RS 777)willbe grown separately in different alternative lines whichwill repeat several times and they would be allowed for random mating. During flowering time healthy and disease free plants would be selected based on variation for next year base population.
Crop/Variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	500 m^2.
Planting spacing	**:**	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding and silking, plant height and ear height, kernel colour and texture, grain yield/plant and disease reaction
Investigator(s)	**:**	A. Ahmed, M.A. Miah and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	December 2020
Date of completion	**:**	May 2021
Expected output/ benefit	**:**	Collection of 300 ears from selected plants.
Location	**:**	Dinajpur
Status	**:**	New
Estimated cost	**:**	Tk. 30,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.2	**:**	**Advancing S_1 to S_2 generation of field corn**
Objective(s)	**:**	To extract elite/superior inbred lines of field corn locally for hybrid development.
Rationale	**:**	Inbred line development constitutes an important part of an overall hybrid development effort. Inbred line development through base

		population can be practiced to develop agronomical desirable lines. In the base population different genotypes are allowed to random mating and to exchange their gene pool for maximum recombination. The program is undertaken for developing elite inbred lines locally.
Materials and methods	**:**	20 S_1 lines developed from Mohabir. Seeds will be sown separately following ear to row method. Undesirable plants will be roughed out at vegetative and flowering stages. Desirable selected plant(s) will be selfed by hand pollination for advancing to S2 generation.
Crop/Variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	200 m2 (Approx)
Spacing	**:**	60 cm×25 cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn and B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS-1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation will be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding and silking, plant height and ear height, colour and texture, grain yield/plant, disease reaction.
Investigator(s)	**:**	M.A. Miah, A. Ahmed and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	S_2 lines would be obtained.
Location	**:**	Dinajpur
Status	**:**	On-going(2^{nd} year)
Estimated cost	**:**	Tk.10,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.3	**:**	**Advancing S_3 to S_4 generation of waxy maize (2 sets)**
Objective(s)	**:**	To extract elite/superior inbred lines of waxy maize locally for hybrid development.
Rationale	**:**	Extraction of superior inbred line(s) through advancing of hybrid is a popular breeding technique. The program was initiated in using two waxy corn materials. This year the materials would be advanced to next generation. The program is undertaken for developing elite inbred lines locally.
Materials and methods	**:**	S_3 ears of- Set I: Xiang waxy corn 2008 (25 lines) and Set II: Xiang waxy corn 932 (25 lines). Seeds would be sown separately following ear to row method. Undesirable plants will be roughed out at vegetative and flowering stages. Desirable selected plant will be selfed hand pollination for advancing to S_2 generation.
Crop/Variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	150 m^2 (Approx)
Spacing	**:**	60 cm×25 cm, row to row and plant to plant, respectively (single plant/hill)

Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS-1st top dress) and before flowering (2^{nd} top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding and silking, plant height and ear height, colour and texture, grain yield/plant, disease reaction.
Investigator(s)	**:**	S.S.Alam and S.H.Omy
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	S_4 lines would be obtained
Location	**:**	Gazipur
Status	**:**	On-going (4^{th} year)
Estimated cost	**:**	Tk.20,000/- per set
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.4.	**:**	**Advancing S_4 to S_5 generation of field corn**
Objective(s)	**:**	To extract superior inbred lines locally
Rationale	**:**	Extraction of superior inbred line(s) through advancing of hybrid is a popular breeding technique. The program was initiated using one field corn material. This year the materials would be advanced to next generation. The program is undertaken for developing elite inbred lines locally.
Materials and methods	**:**	Seeds of S_4 ears of field corn hybrid IM8119 (50 lines) would be grown following ear to row method. Undesirable plants will be roughed out at vegetative and before flowering stages. During plant growth any undesirable plants like too week, too tall would be rouged out whenever observed. During flowering healthy, disease free about 100 plants would be selected and selfed by hand pollination. The selected selfed ears would be harvested and preserved separately for advancing them from S_4 to S_5 generation in next year.
Crop/Variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	Single row 4 m long per line.
Spacing	**:**	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1^{st} top dress) and before flowering (2^{nd} top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding and silking, plant height and ear height, kernel colour and texture, grain yield/plant, disease reaction.
Investigator(s)	**:**	S.S. Alam and S.H.Omy
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	S_5 lines would be obtained

Location	**:**	Gazipur
Status	**:**	On-going(5th year)
Estimated cost	**:**	Tk.20,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.5	**:**	**Advancing S_5 to S_6 generation of sweet corn (2 Sets)**
Objective(s)	**:**	To extract superior inbred lines locally
Rationale	**:**	Extraction of superior inbred line(s) through advancing of hybrid is a popular breeding technique. The program was initiated using two sweet corn materials. This year the materials would be advanced to next generation. The program is undertaken for developing elite inbred lines locally.
Materials and methods	**:**	S_5 ears of- Set I: Dream sweet 2 (20 lines) Set II: Dream sweet 3 (20 lines) The S_4 ears would be grown following ear to row method. The selected plants would be selfed by hand pollination for advancing to S_5 generation.
Crop/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	20m×4m per set.
Spacing	**:**	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding and silking, plant height and ear height and disease reaction of the selected marked plants.
Investigator(s)	**:**	A.N.M.S.Karim and M. Amiruzzaman (Set I and II)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output/ benefit	**:**	S_6 lines would be obtained from different sets.
Location	**:**	Gazipur
Status	**:**	On-going(6thyear)
Estimated cost	**:**	Tk.20,000/- per set
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.2	**:**	Development of source population and inbred lines
Experiment 2.2.6	**:**	**Advancing S_6 to S_7 generation of field corn and baby corn (3 sets)**
Objective(s)	**:**	To extract superior inbred lines locally
Rationale	**:**	Extraction of superior inbred line(s) through recycling of hybrid is a popular breeding technique. The program was initiated using field corn

		and baby corn materials. Last year the materials were advanced from S_4 to S_5 generation and this year need to advance them from S_5 to S_6 generation.
Materials and methods	:	S_5 ears of- Set I: Baby star (20 lines) Set II: Hybrid IM8013 (40 lines) Set III: 981(6 lines) The S_6 ears would be grown following ear to row method. The selected plants would be selfed by hand pollination for advancing to S_6 generation.
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	Single row 4 m long plot for each line in each set.
Spacing	:	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Number of selfed plants, days to 50% pollen shedding and silking, plant and ear height and disease reaction
Investigator(s)	:	S.S. Alam (Set-I), A.N.M.S. Karim (Set-II) and M.A. Miah, A. Ahmed and M. Amiruzzaman (Set III)
Season	:	Rabi
Date of initiation	:	November 2020
Date of completion	:	May 2021
Expected output/ benefit	:	S_7 Materials would be obtained from different sets.
Location	:	Gazipur and Dinajpur
Status	:	On-going(7th year)
Estimated cost	:	Tk. 20,000/- per set
Source of fund	:	BWMRI
Priority	:	First

SUB PROJECT 2.3: EVALUATION OF INBRED LINES

Programme	:	Wheat and Maize Improvement
Project 2	:	Maize Improvement
Sub Project 2.3	:	Evaluation of inbred lines
Experiment 2.3.1	:	**Genetic diversity of locally developed inbred lines**
Objective(s)	:	To characterize and evaluation of locally developed inbred lines.
Rationale	:	BWMRI has developed a number of inbred lines which need to evaluate and characterize for future breeding program.
Materials and methods	:	600 inbred lines. To avoid border effect, one border row at both end of each replication will be planted.
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 2 replications
Plot size	:	One row 2m long plot for each entry.
Planting	:	60cm×25cm, Row to row and plant to plant respectively.

system/spacing		
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded:	**:**	Days to pollen shedding, days to silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, No. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length and breadth and 1000-grain wt. and yield (t/ha)
Investigator(s)	**:**	A. Ahmed, M.A. Miah and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	October 2020
Date of completion		April 2021
Expected output/ benefit	**:**	Better performing hybrid(s) would be selected.
Location	**:**	Dinajpur
Status	**:**	New
Estimated cost	**:**	Tk. 30,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.3	**:**	Evaluation of inbred lines
Experiment 2.3.2	**:**	**Evaluation of inbred lines of field corn through line × tester method (3 Sets)**
Objective(s)	**:**	i) To test the GCA of the inbred lines and SCA of crosses and selection of desirable best cross(es). ii) To find out heterotic patterns and heterotic partners of inbred lines.
Rationale	**:**	Testing of the developing inbred lines in early generation helps to identify better lines (combiners) and discard of low combining lines. In hybrid maize development program, this practice is usually done. Based on the study and analysis, heterotic patterns and heterotic partners (parents) can be identified tested and could be utilized for hybrid development.
Materials and methods	**:**	Set I: 60=54 F_1+ 6 checks Set II: 55=50 F_1+ 5 checks Set III: 40=36 F_1+ 4 checks All the materials in each set would be evaluated along with the commercial checks following alpha lattice design. Each entry will be sown in 2 rows plot.
Crop/variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications.
Plot size	**:**	Single row 4 m long per entry.
Spacing	**:**	60 cm×25 cm, Row to row and plant to plant respectively (single plant/hill).
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding, days to 50% silking and maturity, plant

		and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction and 1000-grain wt.
Investigator(s)	**:**	S. Ahmed, A.H. Akhi (Set-I), M.M. Hoque (Set-II), A.N.M.S. Karim, (Set-III)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion		May 2021
Expected output/ benefit	**:**	Better performing cross combinations would be selected. Good combiner parent lines and testers would also be identified on desirable traits.
Location	**:**	Gazipur
Status	**:**	New
Estimated cost	**:**	Tk. 30,000/- per set/location
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.4: EVALUATION OF SINGLE CROSS HYBRIDS

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.4	**:**	Evaluation of single cross hybrids
Experiment 2.4.1	**:**	**Study on combining ability and heterosis in field corn**
Objective(s)	**:**	i) To study general combining ability (gca) of parents, specific combining ability (sca) effects of the crosses; and ii) To estimate standard heterosis and selection of better cross (es).
Rationale		Single cross hybrid production and selection based on heterosis and combining ability is an important process. Based on combining ability and heterotic patterns heterotic partners of inbred lines can be identified and at the same time better performing single cross hybrid(s) may also be identified. Therefore, the experiments were conducted.
Materials and methods	**:**	25= 21 F_1's + 4 checks
Crop/variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 3 replications
Plot size	**:**	Two rows 4 m long per entry.
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to 50% pollen shedding, days to 50% silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, no. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length, cob diameter and 1000-grain wt.
Season	**:**	Rabi
Investigator(s)	**:**	A. H. Akhi and S. Ahmed
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021

Expected output	**:**	Better performing hybrid(s) would be selected from different sets and good combiner parents would be selected from different sets.
Location	**:**	Gazipur
Status	**:**	New
Estimated cost	**:**	Tk. 20,000/- per set/location
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.4	**:**	Evaluation of single cross hybrids
Experiment 2.4.2	**:**	**Evaluation of selected single cross hybrids of field corn**
Objective(s)	**:**	To test the performance of locally developed single cross hybrids at different agro ecological regions and select widely adapted one(s).
Rationale	**:**	Single cross is always higher yielder than other crosses. Some promising hybrids developed in rabi 2019-2020 need to be evaluated in rabi 2020-2021.
Materials and methods	**:**	Set I: 17=14 single cross field corn hybrids+3 checks To avoid border effect, one border rows at both end of each replication will be planted.
Crop/variety	**:**	Maize
Design and replication	**:**	RCBD lattice with 3 replications
Plot size	**:**	Two rows 4 m long plot for each entry.
Planting system/spacing	**:**	60cm×25cm, Row to row and plant to plant respectively.
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 days emergence-1st top dress) and before flower (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded:	**:**	Days to pollen shedding, days to silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, No. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length and breadth and 1000-grain wt. and yield (t/ha)
Investigator(s)	**:**	M.M. Hoque (Set-I)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion		May 2021
Expected output/ benefit	**:**	Better performing hybrid(s) would be selected.
Location	**:**	Gazipur
Status	**:**	New
Estimated cost	**:**	Tk. 20,000/- per set/location
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.4	**:**	Evaluation of single cross hybrids
Experiment 2.4.3	**:**	**Evaluation of locally developed promising pro vitamin A enriched hybrids**
Objective(s)	**:**	To test the performance of locally developed single cross hybrid(s).
Rationale	**:**	Single cross is always higher yielder than other crosses. Some promising hybrids developed in rabi 2018-19 need to be re-evaluated in rabi 2020-21.
Materials and methods	**:**	28= 24 F_1 + 4 checks To avoid border effect, one border rows at both end of each replication will be planted.
Crop/variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications
Plot size	**:**	Two rows 4 m long plot for each entry.
Planting system/spacing	**:**	60cm×25cm, Row to row and plant to plant respectively.
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 days emergence-1st top dress) and before flower (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded:	**:**	Days to pollen shedding, days to silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, No. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length and breadth and 1000-grain wt. and yield (t/ha)
Investigator(s)	**:**	A. Ahmed (Dinajpur), M.A. Miah (Jashore); S. Ahmed & M.M. Hoque and M. Amiruzzaman(Gazipur)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion		May 2021
Expected output/ benefit	**:**	Better performing hybrid(s) would be selected.
Location	**:**	Dinajpur, Gazipur and Jashore
Status	**:**	On-going
Estimated cost	**:**	Tk. 20,000/- per location
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.4	**:**	Evaluation of single cross hybrids
Experiment 2.4.4	**:**	**Evaluation of promising hybrids of field corn hybrids at different agro-ecological regions (3 sets)**
Objective(s)	**:**	To test the performance of locally developed single cross hybrids at different agro-ecological zones in Bangladesh and select widely adapted hybrids.
Rationale	**:**	Single cross is always higher yielder than other crosses. Better performing single crosses selected from previous year need to be further evaluated in different agro-climatic zones.

Materials and methods	**:**	Set I: 18= 14 selected single cross and 4 checks- Field corn Set II: 16= 13 selected single cross and 3 checks- Field corn Set III: 24=20 test cross hybrid and 4 checks –Field corn To avoid border effect, one border rows at both end of each replication will be planted.
Crop/variety	**:**	Maize
Design and replication	**:**	Alpha lattice design with 2/3 replications
Plot size	**:**	Two to six rows 4 m long plot for each entry.
Spacing	**:**	60cm×25cm, Row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee high (40-45 DAS-1st top dress) and at flower (2nd top
Data to be recorded	**:**	For field corn: Days to pollen shedding, silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, no. of plants harvested, no. of ear harvested, field weight (kg), grain moisture (%), shelling (%), yield (t/ha), no. of rows/cob, no. of seed/row, no. of grains/ear, cob length, cob breadth and 1000-grain weight and disease reaction. For pop corn: Popping percentage. For baby corn, days to pollen shedding, tasseling, plant height, upper and lower ear height, no. of cobs per plant, cob yield and green fodder yield per plant, days to first and last cob harvest, data to be taken for each cob (eg: cob harvest date, wt of cob with and without husk, cob length and diameter of cob without husk
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Investigator(s)	**:**	A.H. Akhi, S. Ahmed, M.A. Miah and A. Ahmed (Set-I); M.M. Hoque, M.I.Riad, A. Ahmed, S. Akhter (Set-II), A. Ahmed, M.A. Miah, M.M. Hoque, M.I.Riad and M. Amiruzzaman(Set III)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	Better performing hybrid(s) would be selected
Location	**:**	Set I(Gazipur, Jashore & Dinajpur); Set II(Gazipur, Jamalpur, Jashore & Dinajpur) & SetIII(Dinajpur, Jashore, Gazipur and Jamalpur)
Status	**:**	New
Estimated cost	**:**	Tk. 20,000/- per set / location
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.4	**:**	Evaluation of single cross hybrids
Experiment 2.4.5	**:**	**Comparative yield trial of imported & local maize hybrids**
Objective(s)	**:**	i) To observe the performance of imported & localhybrids and select better one(s). ii) To share the information of the better performing hybrids to the farmers.
Rationale	**:**	One of the greatest challenges to maize breeder is the obtainment of a hybrid with high mean yield and the widest possible adaptation to

		the various environments. The program is therefore undertaken to find out better performance new hybrid(s) and use of those materials to our breeding program.
Materials and methods	**:**	25: 20 imported hybrids and 5 local hybrids as check. To avoid border effect, one border row at both end of each replication will be planted with any suitable variety.
Crop/variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 3 replications
Plot size	**:**	Two rows 4 m long per entry
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Planting spacing	**:**	60 cm×25 cm, Row to row & plant to plant respectively (single plant/hill)
Irrigation/rainfed	**:**	Irrigation would be applied as and when necessary
Data to be recorded	**:**	Days to flowering and maturity, plant and ear height (cm), lodging percentage, poor husk cover (%), grain yield per plot (kg) and grain yield (t/ha) and disease reaction.
Investigators	**:**	A. Ahmed, M.A. Miah, R. Islam, M. M. Hoque, M.I.Riad and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	Better performance hybrid varieties will be identified.
Location	**:**	Dinajpur, Gazipur, Jamalpur and Jashore.
Status	**:**	**New**
Estimated cost	**:**	Tk. 40,000/- per location
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.5: STRESS BREEDING - ABIOTIC STRESS TOLERANT VARIETY DEVELOPMENT

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.5	**:**	Stress breeding - Abiotic stress tolerant variety development
Experiment 2.5.1	**:**	**Phenotyping of the HTMA hybrids during rabi season (5 Sets)**
Objective(s)	**:**	To evaluate the performances of heat tolerant maize hybrids during rabi season.
Rationale	**:**	Maize production in heat stress areas of Bangladesh through development of heat tolerant hybrid variety is important for increasing income and food security. Moreover, as 87% of maize in Bangladesh is cultivated during rabi season, performance of those HTMA hybrids should also be evaluated during rabi season. Therefore, the present study under Heat Tolerant Maize for Asia (HTMA) project will be conducted to evaluate their performance in rabi season.
Materials and methods	**:**	Approx. 75 crosses including 2-5 checks in each set. To avoid border effect, one border rows at both end of each replication will be planted.
Crop/Variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications

Plot size	**:**	2-4 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding (50% male flower begins pollen shedding), days to silking (50% ear have silks of 2-3 cm length) and days to maturity (black layer formed at the base of kernels of 80% ears per plot), plant and ear height, lodging (stalk and root), number of plants harvested, number of ears harvested, field weight, grain weight, grain moisture (%), shelling %, yield (t/ha).
Investigator(s)	**:**	A. Ahmed and M.A. Miah (3 Sets); S. Ahmed & M. Hoque (3 Sets) and M.A. Miah & R. Islam(2 Sets)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	Suitable hybrid maize variety would be selected for both rabi and kharif (heat stress) seasons.
Locations	**:**	Dinajpur, Gazipur and Jashore
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set
Source of fund	**:**	BWMRI and HTMA project Phase -II
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.5	**:**	Stress breeding - Abiotic stress tolerant variety development
Experiment 2.5.2	**:**	**Evaluation of selected promising maize hybrids for saline areas (2 sets)**
Objective(s)	**:**	To evaluate hybrids and select saline tolerant desirable best one(s).
Rationale	**:**	There are vast areas usually remain unutilized in rabi season in the southern region. There is no maize variety which is tolerant to saline stress. So, it is necessary to develop hybrids of saline tolerant with high yield goal. Therefore, the program is initiated to develop maize hybrids of respective objectives.
Materials and methods	**:**	Set I:15 hybrids + 3 checks Set II: 9 hybrids+ 3 checks- hybrids received from ICBA
Crop/variety	**:**	Maize
Design and replication	**:**	RCBD with 3 replications
Plot size	**:**	4 rows 4 m long per entry.
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding, silking and maturity, anthesis-silking interval (ASI), leaf rolling, SPAD value plant, plant and ear height, number of kernels/ear, 1000-kernel weight, kernel yield/plant, yield/entry (kg), yield (t/ha), disease reaction and salinity.
Investigator(s)	**:**	M.M. Hoque, S. Ahmed, A. Ahmed, M. A. Miah, M.H. Rashid, S. Bhuiyn, M.Mohiuddin, O.A. Fakir , S. Islam and M. Amiruzzaman

Season	**:**	Rabi
Date of initiation	**:**	December 2020
Date of completion	**:**	May 2021
Expected output/	**:**	Desirable promising single cross combination(s) would be selected.
Location	**:**	OFRD, Khulna; OFRD, Cox's Bazar; OFRD, Noakhali, Patuakhali and ARS, Satkhira
Status	**:**	New
Estimated cost	**:**	TK. 25,000/- per location
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.5	**:**	Stress breeding - Abiotic stress tolerant variety development
Experiment 2.5.3	**:**	**Evaluation of promising maize hybrids for haor areas**
Objective(s)	**:**	To identify better performing and early maturing hybrids for haor areas.
Rationale	**:**	In the recent past, sudden flood caused serious damage to crops. Therefore, it is essential to find our early maturing and high yielding maize yields for hoar problem areas.
Materials and methods	**:**	Twenty (20 Approx.) maize hybrids and 2 commercial checks. Seeds would be sown through dibbling method without applying fertilizers. After establishment of plants fertilizers would be applied.
Crop/variety	**:**	Maize
Design and replication	**:**	RCB with 5 dispersed replications
Plot size	**:**	2 rows 4 m long per entry
Planting spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	Seed would be evaluated in dibbling method fertilizer @250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. All fertilizer and one third of urea as basal dose after establishment of crops (basal dose) and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding, silking and maturity, plant and ear height, number of kernels/ear, 1000-kernel weight, kernel yield/plant, yield/entry (kg), yield (t/ha), disease reaction.
Investigator(s)	**:**	M.M. Hoque, M. Mohiuddin and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	October 2020
Date of completion	**:**	April 2021
Expected output/	**:**	Desirable promising hybrids(s) would be selected.
Location	**:**	Haor areas of Kishoregonj
Status	**:**	On-going
Estimated cost	**:**	TK. 40,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.5	**:**	Stress breeding - Abiotic stress tolerant variety development
Experiment 2.5.4	**:**	**Phenotyping of the HTMA hybrids under heat stress(9 Sets)**
Objective(s)	**:**	i) To develop high-yielding and heat tolerant maize hybrids through managed stress screening. ii) To compare the performances of test crosses under optimal and heat stress condition.
Rationale	**:**	The vast majority of heat stress research has been conducted on temperate maize germplasm for high production areas. Therefore, limited breeding progress has been made in the development of improved maize germplasm with specific tolerance to elevated temperatures especially for the tropical/subtropical regions. Most of the tropical maize germplasm were highly susceptible to reproductive stage heat stress. Heat tolerant accessions from Asia and other regions are being intercrossed to produce populations that can be used to develop new cultivars with improved heat tolerance; however, considerable efforts is required to enhance hybrid yield potential of these genotypes in climate change vulnerable environment, such as South Asia and similar ecologies around the world. Maize production in heat stress areas of Bangladesh through development of heat tolerant hybrid variety is important for increasing income and food security. Therefore, the present study under Heat Tolerant Maize for Asia (HTMA) project will be conducted to find out heat tolerant hybrid maize variety for sustainable production for the problem areas.
Materials and methods	**:**	Approx. 781 crosses including 2-6 checks in each set.To avoid border effect, one border rows at both end of each replication will be planted.
Crop/Variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications
Plot size	**:**	1-4 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding (50% male flower begins pollen shedding), days to silking (50% ear have silks of 2-3 cm length) and days to maturity (black layer formed at the base of kernels of 80% ears per plot), plant and ear height, lodging (stalk and root), number of plants harvested, number of ears harvested, field weight, grain weight, grain moisture (%), shelling %, yield (t/ha).
Investigator(s)	**:**	A. Ahmed and M.A. Miah (6 Sets) and M.A. Miah & R. Islam (3 Sets)
Season	**:**	Kharif I/Spring
Date of initiation	**:**	March 2021
Date of completion	**:**	July 2021
Expected output	**:**	Suitable hybrid maize variety would be selected for heat stress condition
Locations	**:**	Dinajpur and Jashore
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set
Source of fund	**:**	BWMRI and HTMA project Phase -II
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.5	**:**	Stress breeding - Abiotic stress tolerant variety development
Experiment 2.5.5	**:**	**Phenotyping of the HTMA hybrids under optimal temperature(5 Sets)**
Objective(s)	**:**	i) To develop high-yielding and heat tolerant maize hybrids. ii) To compare the performances of test crosses under optimal and heat Stress condition.
Rationale	**:**	The vast majority of heat stress research has been conducted on temperate maize germplasm for high production areas. Therefore, limited breeding progress has been made in the development of improved maize germplasm with specific tolerance to elevated temperatures especially for the tropical/subtropical regions. Most of the tropical maize germplasms were highly susceptible to reproductive stage heat stress. Heat tolerant accessions from Asia and other regions are being intercrossed to produce populations that can be used to develop new cultivars with improved heat; however, considerable efforts is required to enhance hybrid yield potential of these genotypes in climate change vulnerable environment, such as South Asia and similar ecologies around the world. Maize production in heat stress areas of Bangladesh through development of heat tolerant hybrid variety is important for increasing income and food security. Therefore, the present study under Heat Tolerant Maize for Asia (HTMA) project will be conducted to find out heat tolerant hybrid maize variety for sustainable production for the problem areas.
Materials and methods	**:**	Approx. 600 crosses including 2-6 checks in each set.To avoid border effect, one border rows at both end of each replication will be planted.
Crop/Variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications
Plot size	**:**	1-4 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding (50% male flower begins pollen shedding), days to silking (50% ear have silks of 2-3 cm length) and days to maturity (black layer formed at the base of kernels of 80% ears per plot), plant and ear height, lodging (stalk and root), number of plants harvested, number of ears harvested, field weight, grain weight, grain moisture (%), shelling %, yield (t/ha).
Investigator(s)	**:**	S. Ahmed and M.M. Hoque (5 Sets)
Season	**:**	Kharif I/Spring
Date of initiation	**:**	March 2020
Date of completion	**:**	July 2020
Expected output	**:**	Suitable hybrid maize variety would be selected for heat stress condition
Locations	**:**	Gazipur
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set
Source of fund	**:**	BWMRI and HTMA project Phase -II
Priority	**:**	First

SUB PROJECT 2.6: PRODUCTION OF NEW HYBRIDS

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.6	**:**	Production of New Hybrids
Experiment 2.6.1	**:**	**Production of single cross fall army worm resistant hybrids through diallel mating**
Objective(s)	**:**	To estimate GCA of the inbreds & SCA of the cross combinations To determine heterotic effect of the crosses and select best one(s).
Rationale	**:**	Production of single cross hybrids through hybridization and to evaluate its performance is a continuous process in maize improvement program. The experiment is undertaken with different combinations of fall army worm resistant inbreds for producing and selecting best cross combinations with fall army worm resistant characters & to identify suitable parents.
Materials & methods	**:**	9 × 9 diallel fashion excluding reciprocals-Yellow Sowing will be done in three different dates for synchronization. Hand pollination will be followed to produce F_1 seeds of respective crosses.
Crop/variety	**:**	Maize
Design & replication	**:**	Not applicable
Plot size	**:**	2-3 rows 2m long for each entry in each set.
Planting spacing	**:**	60cm×25cm, Row to row & plant to plant respectively (one plant/hill)
Fertilizer dose & application method	**:**	120, 35, 70, 40 and 5 kg/ha of N, P, K, S and Zn respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to pollen shedding and silking, plant and ear height, weight of each crossed seed (g) and disease reaction.
Investigator(s)	**:**	A. Ahmed, M.A. Miah & Dr. S. Ahmed
Season	**:**	Rabi
Date of initiation	**:**	October 2020
Date of completion	**:**	March 2021
Expected output/ benefit	**:**	Sufficient F_1 seeds of single cross combinations would be obtained in each set for evaluation.
Location	**:**	Dinajpur
Status	**:**	New
Estimated cost	**:**	Tk. 20,000/- per set
Source of fund	**:**	Improvement and quality seed production of wheat and maize project
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.6	**:**	Production of New Hybrids
Experiment 2.6.2	**:**	**Seed production of promising maize hybrids of field corn and popcorn (7 Sets)**
Objective(s)	**:**	To increase the hybrid seeds stock of the promising maize hybrids for demonstration and distribution.
Rationale	**:**	The seeds of the selected single crosses from last year's trials need to further increase for verifying them in wider agro-ecological zones. Hence the program is initiated to produce sufficient amount of seeds from the selected different crosses in isolation.

Materials and methods	**:**	7 set (Set I: 15 promising Pro Vitamin-A enriched hybrids, Set II: 96 promising short duration hybrids, Set III: 250 high yielding maize hybrids, Set IV: 19 promising popcorn hybrids). Set V: Six promising maize hybrids (BAM005×BIL28, BAM006×BIL28, BAM009×BIL28, BAM010×BIL28, BAM013×BIL28 and BAM015×BIL28). Sowing time of females and males will be adjusted for synchronization of flowering. Male parent will be sown in three different dates for synchronization of flowering. Undesirable plants of both male and female will be rouged out at seedling, vegetative and pre-flowering stages. Cross will be done by hand pollination. Two crosses (BML75 x BIL79 and BML249 x BIL157) will be done under open pollination in isolation.
Crop/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	600 m^2
Planting	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	**:**	A. Ahmed (Set 1-IV) and M.A. Miah (Set V), S. Rahman & M.M. Hoque (Set VI & VII).
Season	**:**	Rabi
Date of initiation	**:**	October 2020
Date of completion	**:**	April 2021
Expected output	**:**	About 0.5-1 kg F_1 seeds of each hybrid would be obtained.
Locations	**:**	Dinajpur and OFRD, Sherpur
Status	**:**	On-going
Estimated cost	**:**	Tk.30,000/-+ 50,000/=
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.6	**:**	Production of New Hybrids
Experiment 2.6.3	**:**	**Seed Production of single cross maize hybrids though Line×Tester method in isolation (2 Sets)**
Objective(s)	**:**	i) To produce test cross hybrids for evaluation of inbred lines; and ii) To find out heterotic patterns and heterotic partners of inbred lines.
Rationale	**:**	Evaluation of inbred line through line × Tester method is a useful tool to select efficient/elite inbred. For this reason, development of single cross hybrid through line × tester method in isolation is initiated. All the inbred lines would be detaselled before flowering and would be treated as female (one tester in one location). Sowing time of male and female parents will be adjusted for nicking.
Materials and methods	**:**	About 150 lines will be crossed with 2 testers of opposite heterotic groups
Crop/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	2 rows 4 m long for each inbred line.

Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to pollen shedding and silking, plant and ear height, amount of F_1 seed produced in each hybrid
Investigator(s)	**:**	M.M. Hoque, S. Ahmed, M. Rahman (Norshingdi) and J. H. Prodhan (TCRC, Bogura)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output/ benefit	**:**	Sufficient F_1 seeds of each cross combinations in each set would be obtained for next evaluation.
Locations	**:**	RHRC, Norshingdi and TCRC, Bogura
Status	**:**	New
Estimated cost	**:**	Tk.30,000/- per set/location
Source of fund	**:**	BWMRI

SUB PROJECT 2.7: MAINTENANCE AND SEED INCREASE OF PARENTAL/INBRED LINES

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.7	**:**	Maintenance and seed increase of parental/inbred lines
Experiment 2.7.1	**:**	**Maintenance and seed increase of the parental lines of different released maize hybrids**
Objective(s)	**:**	To maintain purity of the parental lines for further use.
Rationale	**:**	In maize breeding program maintenance of parent lines is pre-requisite for maintaining the quality of the respective inbred lines. So for we have developed a number of hybrid maize variety. For maintaining the purity of those hybrids, parent line maintenance is one of the prime works. Therefore, this regular work is very necessary for maintaining purity of the hybrids.
Materials and methods	**:**	26 parents: (BIL 20, BIL 22, BIL 28, BIL 29, BIL 31, BIL 77, BIL 79, BIL 106, BIL 110, BIL 113, BIL 114,BIL 157, BIL 210, BIL 211, BIL 212, BIL 213, BIL 214, BIL 215, BIL 216,BIL 217, BML 36, BML59, BML71, BML 73, BML 74 and BML 79) The parental lines will be maintained carefully through selfing of selected plants by hand pollination.
Corp/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	Each parent line would be grown in 2 rows 4 m long plot.
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height and disease reaction.

Investigator(s)	**:**	A. Ahmed & M.A. Miah(Dinajpur) and S. Ahmed & M.K. Alam(Gazipur)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output/ I	**:**	True to type seeds of the parent lines of different BARI maize hybrid would be obtained for future use.
Locations	**:**	Dinajpur & Gazipur
Status	**:**	On-going
Estimated cost	**:**	Tk. 20,000/-
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.7	**:**	Maintenance and seed increase of parental/inbred lines
Experiment 2.7.2	**:**	**Seed production of the parental lines of different released maize hybrids (11 sets)**
Objective(s)	**:**	To produce breeder seed of the parental lines for further use. To distribute the increased seed to BADC and other private agencies.
Rationale	**:**	It is very necessary to increase large scale seed production of the parental lines of already released maize hybrids for large scale hybrid (F_1) seed production to decrease importing of hybrid seed and save valuable foreign currency. In order to provide large scale breeder seed of different parental lines to BADC and other seed companies, the program is undertaken.
Materials and methods	**:**	11 set parents (BIL28, BIL 114, BIL210, BIL 211, BIL 157, BML 59, BML 71, BML 73, BML 74, BML 79 and BIL79). The parental lines will be maintained through open pollination in isolation (Time isolation: 1 month or space/distance isolation: 400m).
Corp/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	1,000 – 10,000m^2 per inbred
Spacing	**:**	60cm×25cm, row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn and B respectively. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height and disease reaction
Investigator(s)	**:**	A. Ahmed, M.A. Miah(Dinajpur); S. Ahmed, M.M. Hoque and M. Amiruzzaman(Gazipur); Md A. Alam(Bogura); B Sarker(RARS, Rangpur); S. Rahman(OFRD, Sherpur; Mohammad Mohiuddin(OFRD, Kishoreganj), H Hossain (OFRD, Cumilla)
Season	**:**	Rabi
Date of initiation	**:**	October to December 2020
Date of completion	**:**	April to June 2021
Expected output/ I	**:**	Approx. 200 – 2,000 kg seeds of each parental line of different maize hybrids would be obtained for future use.
Locations	**:**	BIL 157 & 211-BWMRI, Rajshahi (0.40 hac.); BML 71-BWMRI, Thakurgaon (0.10 ha.); BML 79- BWMRI, Debigong (0.15 ha.); BML 59- Sat mile, BWMRI, Dinajpur (1.00 ha.); BIL28-SRC, Bogura;

		BIL114-OFRD, Sherpur(0.05 ha); BIL79- OFRD, Kishoreganj(0.05 ha) and OFRD, Cumilla (0.04 ha); RARS, Rangpur BIL210(0.05 h),
Status	**:**	On-going
Estimated cost	**:**	Tk.300/-per 100m^2
Source of fund	**:**	BWMRI
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.7	**:**	Maintenance and seed increase of parental/inbred lines
Experiment 2.7.3	**:**	**Seed production of the parental lines of promising maize hybrid(3 sets)**
Objective(s)	**:**	To produce breeder seed of the parental lines for further use. To distribute the increased seed to BADC and other private agencies.
Rationale	**:**	It is very necessary to increase large scale seed production of the parental lines of promising maize hybrids for large scale hybrid (F_1) seed production to decrease importing of hybrid seed and save valuable foreign currency. In order to provide large scale breeder seed of different parental lines to BADC and other seed companies, the program is undertaken.
Materials and methods	**:**	3 set parents (BAM015, BIL 28 and BML76). The parental lines will be maintained through open pollination in isolation (Time isolation: 1 month or space/distance isolation: 400m).
Corp/variety	**:**	Maize
Design and replication	**:**	Not applicable
Plot size	**:**	1,000 m^2 BAM015 and 500sqm for BML
Spacing	**:**	60cm×25cm, row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn and B respectively. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height and disease reaction
Investigator(s)	**:**	M.A. Miah, S.Rahman, M.M.Hoque, and R. Islam
Season	**:**	Rabi
Date of initiation	**:**	October to December 2020
Date of completion	**:**	April to June 2021
Expected output	**:**	Approx. 200 kg seed of BAM015 and 100 kg seed of BIL28 will be obtained for future use.
Locations	**:**	Jashore and OFRD, Sherpur
Status	**:**	New
Estimated cost	**:**	Tk. 30000/= per sets
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.8: SEED PRODUCTION OF DIFFERENT RELEASED HYBRIDS

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.8	**:**	Seed Production of different released hybrids
Experiment 2.8.1	**:**	**Seed production of BARI/WMRI hybrid maize (7 Sets)**
Objective(s)	**:**	To increase the hybrid seeds stock of the promising released maize hybrids for demonstration and distribution.
Rationale	**:**	Seed is pre-requisite for popularizing the released maize hybrids to the farmers and maize growers. For conducting demonstrations throughout the country, large scale of hybrid seed is needed. Therefore, the program is under taken.
Materials and methods	**:**	Sowing of female and male parent of specific hybrid should be done in isolation (time/space) maintaining a ratio of four female rows alternate with two male rows (4:2). Sowing time of females and males will be adjusted for synchronization of flowering. Male parent will be sown in two different dates (within 2nd week of Nov.) for synchronization of flowering. At flowering time all female plants will be detasseled properly before pollen shedding. Undesirable plants of both male and female will be rouged out at seedling, vegetative and pre-flowering stages. Male plants should be harvested from the field 3-5 days before female. (Time isolation:1 month or Space/distance isolation: 400m).
Crop/variety	**:**	Maize
Plot size		Set I- BHM 16 (2.35ha.)-BWMRI, Debigonj; Set II - BHM 17 (0.70ha.)- BWMRI, Thakurgaon; Set III – BHM 9 (0.30ha.)- BWMRI, Gazipur and RARS, Ishardi Set IV-BHM-14(0.20 ha)- ARS, RajbariSet V-WMRI baby corn hybrid- RARS. Ishurdi Set VI- BHM7 (0.03)-RARS, Hathazari Set VII: BHM15(0.05 ha)-RARS, Jamalpur
Design and	**:**	Not applicable
Planting	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	**:**	A. Ahmed, M.A. Miah, S. Ahmed, M.M. Hoque, M.I.Riad, M.S. Huda and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	1st-2nd week of October 2020
Date of completion	**:**	April 2021
Expected output/ benefit	**:**	About 4 tons F_1 seeds of BHM 16 1 ton of BHM 17, 300 kg of BHM-9 and 300 kg of BHM-14 will be produced.
Locations	**:**	Debigonj, Thakurgaon , Gazipur, Rajbari, Ishurdi, Hathazari and Jamalpur
Status	**:**	On-going
Estimated cost	**:**	Tk.2,75,000/-(Tk. 3,000/- per 100 m^2)
Source of fund	**:**	BWMRI
Priority	**:**	First

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.8	**:**	Seed Production of different released hybrids
Experiment 2.8.2	**:**	**Seed production of promising maize hybrid**
Objective(s)	**:**	To increase the hybrid seeds stock of the promising released maize hybrids for demonstration and distribution.
Rationale	**:**	Seed is pre-requisite for popularizing the released maize hybrids to the farmers and maize growers. For conducting demonstrations throughout the country, large scale of hybrid seed is needed. Therefore, the program is under taken.
Materials and methods	**:**	Sowing of female and male parent of specific hybrid should be done in isolation (time/space) maintaining a ratio of four female rows alternate with two male rows (4:2). Sowing time of females and males will be adjusted for synchronization of flowering. Male parent will be sown in two different dates (within last week of October) for synchronization of flowering. At flowering time all-female plants will be detasseled properly before pollen shedding. Undesirable plants of both male and female will be rouged out at seedling, vegetative and pre-flowering stages. Male plants should be harvested from the field 3-5 days before female. (Time isolation:1 month or Space/distance isolation: 400m).
Crop/variety	**:**	Maize
Plot size	**:**	BAM015×BIL28 (1500sqm)-RS, BWMRI, Jashore BML249xBIL157(400 sqm)-RARS, Jamalpur BML76xBIL106(400 sqm)-OFRD, Pabna
Design and	**:**	Not applicable
Planting	**:**	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	**:**	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	**:**	Irrigation should be applied as and when necessary.
Data to be recorded	**:**	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	**:**	M.A. Miah, R. Islam (Jashore), R Islam (Pabna) M.I.Riad and M.M.Hoque
Season	**:**	Rabi
Date of initiation	**:**	2nd week of October 2020
Date of completion	**:**	April 2021
Expected output/ benefit	**:**	About 300 kg of F_1 seed of BAM015XBIL28 will be produced.
Locations	**:**	Jashore, OFRD, Pabna and RARS, Jamalpur
Status	**:**	New
Estimated cost	**:**	Tk.300/-per 100m^2
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.9: MAINTENANCE AND SEED PRODUCTION OF OPEN-POLLINATED VARIETIES

Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.9	**:**	Maintenance and seed production of Open-pollinated varieties
Experiment 2.9.1	**:**	**Maintenance and seed production of composite maize varieties (2 Sets)**
Objective(s)	**:**	i) To supply breeder`s seed to BADC and other organization; ii) To maintain the purity of the popular composite varieties; iii) To supply seed directly to farmers.
Crop/variety	**:**	Maize
Design and replication		Not applicable
Spacing	**:**	60×25cm, Row to row and plant to plant respectively (one plant/hill)
Rationale	**:**	It is a routine work to maintain and increase breeder seeds of the popular released composite varieties.
Materials and methods	**:**	Khoibhutta and BARI Sweet Corn 1 Half-sib method (two rows female alternate with one row male) will follow and female rows plants will be detasseled before pollen shedding. Time or space isolation will be maintained. Rouging of undesirable plants from both female and male rows will be done at vegetative and just before flowering stages i.e. before pollen shedding.
Design and replication	**:**	Not applicable
Plot size	**:**	1,000m^2 (Sat mile, Dinajpur) and 500m^2 (Thakurgaon)
Fertilizer dose and application method	**:**	120, 35, 70, 40 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Days to tasseling and silking, plant height, disease reaction and seed yield (t/ha).
Investigator(s)	**:**	A. Ahmed, M.A. Miah and M. Amiruzzaman
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output/ benefit	**:**	Approx. 400 kg seeds from each set would be obtained.
Locations	**:**	Sat mile, Dinajpur and Thakurgaon
Status	**:**	On-going
Estimated cost	**:**	Tk.30,000/-(Tk.3,000 per 100 m^2)
Source of fund	**:**	BWMRI
Priority	**:**	First

SUB PROJECT 2.10: COLLABORATIVE PROGRAMS/ TECHNOLOGY TRANSFER ACTIVITIES

Programme	:	Wheat and Maize Improvement
Project 2	:	Maize Improvement
Sub Project 2.10	:	Collaborative Programs/ Technology Transfer Activities
Experiment 2.10.1	:	**On-farm evaluation of HTMA hybrids with popular checks (Selections from 19 S CRTs) (8 Sets)**
Objective(s)	:	Disseminate and popularize the hybrids to the farmers
Rationale	:	Selected HTMA hybrids need to evaluate among the farmers and private agencies before recommended as a variety. This helps to know the adaptability of the hybrids as well as farmers' opinion.
Materials and methods	:	10 selected HTMA hybrids along with popular commercial checks.
Crop/Variety	:	Maize
Design and replication	:	Dispersed replication
Plot size	:	5 rows 4 m long plot per entry
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	:	Irrigation should be applied as and when necessary
Data to be recorded	:	Maturity (days), yield (t/ha), disease & insect reaction & farmers opinion.
Investigator(s)	:	A. Ahmed, M.A. Miah and S. Ahmed (6 Sets) and M.A. Miah and S. Ahmed (2 Sets)
Season	:	Rabi
Date of initiation	:	November 2020
Date of completion	:	May 2021
Expected output	:	Suitable hybrid maize variety would be selected for kharif season.
Locations	:	Dinajpurand Jashore
Status	:	New
Estimated cost	:	Tk: 35,000/- per set
Source of fund	:	BWMRI and HTMA project Phase -II
Priority	:	First

Programme	:	Wheat and Maize Improvement
Project 2	:	Maize Improvement
Sub Project 2.10	:	Collaborative Programs/ Technology Transfer Activities
Experiment 2.10.2	:	**On-farm evaluation of HTMA hybrids with popular hybrids (Selections from 19 K CRTs) (8 Sets)**
Objective(s)	:	Disseminate and popularize the hybrids to the farmers
Rationale	:	Selected HTMA hybrids need to evaluate among the farmers and private agencies before recommended as a variety. This helps to know the adaptability of the hybrids as well as farmers' opinion.
Materials and methods	:	18 selected HTMA hybrids along with popular commercial checks.
Crop/Variety	:	Maize
Design and replication	:	Dispersed replication

Plot size	**:**	5 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Maturity (days), yield (t/ha), disease & insect reaction & farmers opinion.
Investigator(s)	**:**	A. Ahmed, M.A. Miah and S. Ahmed (6 Sets) and M.A. Miah and S. Ahmed (2 Sets)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	Suitable hybrid maize variety would be selected for rabi/kharif season.
Locations	**:**	Dinajpur and Jashore
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set
Source of fund	**:**	BWMRI and HTMA project Phase -II
Priority	**:**	First
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.10	**:**	Collaborative Programs/ Technology Transfer Activities
Experiment 2.10.3	**:**	**On-farm evaluation of HTMA hybrids with popular hybrids (2 Sets)**
Objective(s)	**:**	Disseminate and popularize the hybrids to the farmers
Rationale	**:**	Selected HTMA hybrids need to evaluate among the farmers and private agencies before recommended as a variety. This helps to know the adaptability of the hybrids as well as farmers' opinion.
Materials and methods	**:**	15 selected HTMA hybrids along with popular commercial checks.
Crop/Variety	**:**	Maize
Design and replication	**:**	Dispersed replication
Plot size	**:**	10 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Maturity (days), yield (t/ha), disease & insect reaction & farmers opinion.
Investigator(s)	**:**	A. Ahmed, M.A. Miah and S. Ahmed (1 Set) and M.A. Miah and S. Ahmed (1 Set)
Season	**:**	Rabi
Date of initiation	**:**	November 2020
Date of completion	**:**	May 2021
Expected output	**:**	Suitable hybrid maize variety would be selected for rabi season.
Locations	**:**	Dinajpur and Jashore
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set

Source of fund	**:**	BWMRI and HTMA project Phase -II
Programme	**:**	Wheat and Maize Improvement
Project 2	**:**	Maize Improvement
Sub Project 2.10	**:**	Collaborative Programs/ Technology Transfer Activities
Experiment 2.10.4	**:**	**On farm CIMMYT-Asia Regional Trials (CRT) based on selections from Stage III of Spring 2020 (6 Sets)**
Objective(s)	**:**	Disseminate and popularize the hybrids to the farmers
Rationale	**:**	CRThybrids need to popularize among the farmers and private agencies
Materials and methods	**:**	26 selected CRT hybrids along with popular commercial checks.
Crop/Variety	**:**	Maize
Design and replication	**:**	Alpha lattice with 2 replications
Plot size	**:**	4 rows 4 m long plot per entry
Spacing	**:**	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	**:**	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/ rainfed	**:**	Irrigation should be applied as and when necessary
Data to be recorded	**:**	Maturity (days), yield (t/ha), disease & insect reaction & farmers opinion.
Investigator(s)	**:**	A. Ahmed, M.A. Miah and S. Ahmed (4 Sets) and M.A. Miah and S. Ahmed (2 Sets)
Season	**:**	Kharif I/Spring
Date of initiation	**:**	March 2021
Date of completion	**:**	July 2021
Expected output	**:**	Suitable hybrid maize variety would be selected for rabi/kharif season.
Locations	**:**	Dinajpur and Jashore
Status	**:**	New
Estimated cost	**:**	Tk: 35,000/- per set
Source of fund	**:**	BWMRI and HTMA project Phase -II
Priority	**:**	First

PROJECT 3: CROP AND SOIL MANAGEMENT

SUB-PROJECT 3.1: CROP MANAGEMENT

1.Programme	**:**	Wheat and Maize Improvement
2.Project 3	**:**	Crop and Soil Management
Sub-Project 3.1	**:**	Crop Management
Sub-Sub-Project 3.1.1	**:**	**Resource Conservation**
3.Plan/Expt. 3.1.1.1	**:**	**Long-term bed planting trial for improving crop and soil productivity in rice-wheat-mungbean cropping pattern**
4.Objective(s)	**:**	i. Increasing cropping intensity and soil fertility ii. Determining N-use efficiency iii. Creating a suitable cropping pattern within the rice-wheat system, and iv. Study the profitability of this pattern.
5.Rationale	**:**	With the introduction of high yielding varieties of rice and wheat, a significant change has been made in crop management. Inefficient use of fertilizer, irrigation water, light etc. might be the major cause of yield gap between research and farmers' fields. High yielding varieties are highly nutrient responsive. Bed planting has shown to improve water distribution and efficiency, fertilizer use efficiency, reduced weed infestation, reduce lodging and it also reduces seed rate without sacrificing yield (Hobbs et al., 1998). It also reduces cost of cultivation, soil erosion and degradation, increases soil organic matter and is more beneficial for bioactivity. An additional advantage of bed planting becomes apparent when beds are "Permanent" i. e. when they are maintained over the medium term and not broken down and reformed for every crop. It may be an interesting alternative for Bangladesh. The project has been undertaken with the hypothesis that, bed planting will not only increase crop yield but also save money and increase soil health over the long run.
6.Materials/Methods	**:**	Treatments: Factor A: Methods of cultivation (horizontal treatment) i) Conventional ii) Bed planting Factor B: Straw management (vertical treatment except mungbean) i) 30% straw ii) 0% straw Factor C: Nitrogen levels in sub-sub plot i) 0 ii) 40 iii) 80 v) 100 and vi) 120% N as recommended dose In Rice recommended dose of PKSZn should be used In Wheat recommended dose of PKS should be used
Variety	**:**	Wheat- BARI Gom 24, Rice- BRRI dhan 49 & Mungbean- BARI Mung 6
Design	**:**	Strip split plot with 3 replications
Plot size	**:**	10×3m
Planting system and spacing	**:**	Bed & conventional planting with 20 cm spacing
Fertilizer dose and method of application	**:**	**Recommended fertilizer will be applied in each crop as follows:** **Wheat: $N_{120}P_{30}K_{50}S_{20}B_{1.5}$** **Maize: $N_{210}P_{60}K_{100}S_{40}Zn_5B_{1.5}$** Rice: $N_{90}P_{30}K_{50}S_{20}$
Irrigated/Rainfed	**:**	Irrigated
Data to be recorded	**:**	i. Physical and chemical properties of the soil (0-15 and 15-30 cm) ii. Composite soil nutrient status at initial stage

iii. Weed species and their biomass after1st irrigation
iv. Grain growth parameters
v. Yield and yield components, harvest index and biomass
vi. Grain and straw samples analysis after each crop harvested
vii. Economic analysis after completion the work
viii. Weather parameters

7.Investigator : MI Hossain, MK Gathala, TP Tiwari and McdonaldAndraw
8.Season : 2020-2021
9.Date of initiation : November 2020
10.Date of completion : April 2021
11.Expected outputs : It will improve productivity of all crops and the pattern due to efficient utilization of nitrogen, irrigation water and other inputs. Exploitation of the advantages of high fertility in bed planting will be possible, as it enhances lodging resistance. Soil organic matter may be increased after inclusion of mungbean crop and other residues.
12.Location : RWRC, Shyampur, Rajshahi
13.Status : On-going (17th year)
14.Estimated cost : Tk. 1,50,000/-
15.Source of Fund : BWMRI
16.Priority : 1
17.Remarks :

Programme : Wheat and Maize Improvement
Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.1 : **Resource Conservation**
Plan/Expt. 3.1.1.2 : **Weed management of Wheat-Mungbean-Rice cropping pattern in CA at drought prone Rajshahi region**
Objective(s) : i. To find out the effective and sustainable weed control measurements on CA
ii. To get sustainable potential yield for controlling weeds under CA
Rationale : Conservation agriculture (CA) has been said to result in sustainable farming systems because of saving on time economic inputs and preserving natural resources. There has been an increasing trend toward CA to enhance sustainability without compromising land productivity over the last decade in South Asia. However, adoption of CA influences by different weed populations. Weed control is a greater challenge to achieve the success of CA. The behavior of weeds under CA is complex and not fully understood. Generally, in CA weed seed bank remains at the surface soil. Weed seeds at soil surface are more prone to withering. In addition, crop residues are pillar of CA could suppress or delay weed emergence and allow the crop to gain early vigor over weeds. Further, crop residues may also intercept a considerable proportion of pre-emergence herbicides may result in lower herbicide efficacy. However, it is critical to control weed to achieve the success of CA in Bangladesh. Still now less effort has been taken for managing weed and improving crop yields in South Asia.
Materials/Methods : Treatments:
Factor A (Tillage options):
1. Strip tillage
2. Zero tillage
3. Permanent bed
4. Minimum tillage
5. Convention tillage

In case of rice crop, unpuddled transplanting method was used for strip

tillage, zero tillage and bed planting. About 30% crop residue was recycled for different tillage treatment.

Factor B: (weed management options):

Weed management options varied in different crops. The weed management treatment combinations was detailed below-

Treatment	Wheat	Mungbean	Rice
WM_1	Pre-plant: Glyphosate (Round- up)	Pre-plant: Glyphosate (Roundup) Pre-emergence: Sunrise	Pre-plant: Glyphosate (Roundup) Pre-emergence: Bensulfuron methyl+ Acetachlor (Nirmul-18WP)
WM_2	Post emergence: Carfentrazone- ethyle (Affinity)	Post emergence: Fenoxaprop-ethyl (Whisopher)	Post-emergence: Bensulfuronmethyl+Bispyribac Sodium (Sirious Plus 300 WP)
WM_3	Hand weeding at 25-30 DAS	Hand weeding at 15- 20 DAS	Hand weeding at 30-35 DAS
WM_4	Absolute control	Absolute control	Absolute control

Design : Split plot with 3 replications
Plot size : 10m×3m
Fertilizer dose and method of application : Recommended fertilizer will be applied
Irrigated/Rainfed : Irrigated
Data to be recorded :
i) Weed species and their biomass after 1st irrigation and 45 DAS
ii) Observation on crops after spraying weedicides if any changes
iii) Phonological parameters
iv) Grain growth parameters
v) Yield and yield components, harvest index and biomass
vii) Economic analysis after completion the work
viii) Weather parameters
Investigator : M IliasHossain, MZ Hossain, TP Tiwari, MKGathala
Season : 2020-21
Date of initiation : November 2020
Date of completion : April 2021
Expected outputs : It will improve productivity of all crops and the pattern to controlling weeds and efficient utilization of nitrogen, irrigation water and other inputs. Increase crops yield through weed management in the pattern.
Location : RWRC, Rajshahi
Status : New
Estimated cost : Tk. 1,00,000/-each location
Source of Fund : BWMRI
Priority : 1
Remarks

Programme : Wheat and Maize Improvement
Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.1 : **Resource Conservation**
Plan/Expt. 3.1.1.3 : **Effect of fertilizer doses with biochar on soil fertility and crop productivity of wheat-maize-rice cropping pattern in drought prone area**

Objective(s) :
i. To determine the optimum doses of wheat-maize-rice cropping pattern with Boichar application
ii. To evaluate the effect of biochar to improving the system productivity and
iii. 3. To study the change in soil properties over time in the intensified cropping patter

Rationale : Biochar is defined simply as charcoal that is used for agricultural purposes. It is created using a pyrolysis process, heating biomass in a low oxygen environment. Once the pyrolysis reaction has begun, it is self-sustaining, requiring no outside energy input. Byproducts of the process include syngas (H2 + CO), minor quantities of methane (CH4), tars, organic acids - and excess heat. Once it is produced, biochar is spread on agricultural fields and incorporated into the top layer of soil. Biochar has many agricultural benefits. It increases crop yields, sometimes substantially if the soil is in poor condition. It helps to prevent fertilizer runoff and leeching, allowing the use of less fertilizers and diminishing agricultural pollution to the surrounding environment. It retains some moisture, possibly helping plants through periods of drought more easily. Most importantly, it replenishes exhausted or marginal soils with organic carbon and fosters the growth of soil microbes essential for nutrient absorption. Studies have indicated that the carbon in biochar remains stable for millenia, providing a simple, sustainable means to sequester historic carbon emissions that is technologically feasible in developed or developing countries alike. The syngas and excess heat can be used directly or employed to produce a variety of biofuels.

When biochar is created from biomass, approximately 50% of the carbon that the plants absorbed as CO2 from the atmosphere is "fixed" in the charcoal. As a material, the carbon in charcoal is largely inert, showing a relative lack of reactivity both chemically and biologically, and so it is strongly resistant to decomposition. Research scientists have found charcoal particles as old as 400 million years in sediment layers from wildfires that occurred when plant life first began on earth. *(Sediment Records of Biomass Burning and Global Change, James Samuel Clark)* of the many organic and inorganic substances that contain carbon atoms, only diamonds could potentially provide a more permanent carbon store than charcoal. Hence, biochar offers us a golden opportunity to remove excess CO2 from the atmosphere and sequester it in a virtually permanent and environmentally beneficial way.

Land degradation and soil fertility decline are among the main causes of the stagnation and fall of agricultural production in many tropical countries, including those with intensive irrigated cropping systems. Inclusion of maize in the dry-wet transition of rice-wheat cropping system as a third crop may be another options of increasing cropping intensity, soil fertility and productivity of the system. Although the non-rice season across the rice-wheat area is low rainfall, heavy pre-monsoonal rain can have disastrous effects on the third crop, such as

maize grown after wheat or before rice, both during establishment and grain filling because of water logging (Timsina and Connor, 2001; Quayyam*et al.*, 2002). Crop residues are an important source of soil organic matter vital for the sustainability of agricultural ecosystems. About 25% of N and P, 50% of S and 75% of K uptake by cereal crops is retained in crop residues, making them valuable nutrient sources (Singh 2003). However, straw retention is not a common practice in the RW systems of Bangladesh, as is also the case elsewhere in SouthAsia. Wheat and rice straw are usually removed from fields for use as cattle feed and for purposes such as livestock bed ding, thatching material for houses or for fuel, leaving little for incorporation into the soil. Due to the limited number of livestock, farmers throughout the IGP have access to very limited amounts of organic manure. As a result, soil organic matter levels have declined in these cropping systems, and optimization of nutrient uptake and absorption efficiency has become one of the most important goals in crop production strategies. Limon-Ortega *et al*. (2000) observed that permanent beds with straw retention had the highest mean wheat grain yields (5.57 t/ha), N use efficiency (28.2 kg grain/kg of N supply) and total N uptake (133 kg/ha), with positive implications for soil health. Thus, crop residue management along with efficient fertilizers dosess, are likely to be key components of new farming practices that can increase and maintain yields from the intensive RW system in Bangladesh. Potassium is one the key limiting nutrients for plant growth and development. Due to intensive cropping mining of potassium from soil reserves is now a great concern to researchers. Removal of potassium through crop harvest and non-recycling of crop residues is being posed a thread for sustainable crop production in the country. Though silica is not considered as essential plant nutrient, many researches claims that it gives substantial resistance capacity to plants against stress conditions including pest and disease. Kaya et al. (2006) also reported this element helps to improve yield traits and yield of crops through contribution of potential physiological process. Biochar (after burning of crop residues) is now available in Bangladesh is considered a good source of all nutrients and silica. Climate change induces different stress at farming environment.

Materials/Methods : Treatments:
T1=Control
T2=Recommended Fertilizer
T3= 90%+Recommended Fertilizer+ Biochar 1 t/ha
T4= 80%+Recommended Fertilizer+ Biochar 2 t/ha
T5= 70%+Recommended Fertilizer+ Biochar 3 t/ha

Design : RCB with 3 replications

Plot size : 5 m×3m

Fertilizer dose and method of application : Recommended fertilizer will be applied

Irrigated/Rainfed : Irrigated

Data to be recorded : i) Initial soil sample collection and analysis nutrients
ii) Phonological parameters
iii) Grain growth parameters
iv) Yield and yield components, harvest index and biomass
v) Economic and nutrient balance analysis after completion the work
vi) Weather parameters

Investigator : M Ilias Hossain, M Mahbub, M MAlam, M Z Islam, M Gathala

Season : 2020-21

Date of initiation : November 2020

Date of completion : April 2021
Expected outputs : Determine optimum doses of fertilizers with biochar added in the pattern. It will improve soil fertility and productivity of all crops. Improve nutrient balanced and soils
Location : RWRC, Rajshahi
Status : New
Estimated cost : Tk. 1,00,000/-
Source of Fund : BARI, BARI
Priority : 1

1. Programme : Wheat and Maize Improvement
2. Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1 : **Resource Conservation**
3. Plan/Expt. 3.1.2.4. : **Integrated fertilizer management on soil fertility and productivity of Wheat -T. Aus –T. Aman cropping pattern**

4. Objective(s) :
i. To find out a suitable combination of vermicompost with chemical fertilizers for growth and yield of wheat, and
ii. To sustain the soil fertility and productivity

5. Rationale : In Bangladesh most of the soils have less than 1.5%, and some soils even less than 1% organic matter (FRG 12). As a result, excessive use of chemical fertilizers decline soil and food quality in conventional farming systems (Singh *et al*., 2007; Melero*et al*., 2008; Liu *et al*., 2009). Therefore must be considered a good alternative for these types of fertilizers (Kochaki*et al*. 2008). One solution could be the use of vermicompost organic manure. Vermicomposts are organic materials broken down by interactions between microorganism and earthworms with low C:N ratios. Vermicompost contains an average of 1.5% - 2.2% N, 1.8% - 2.2% P and 1.0% - 1.5% K. The organic carbon is ranging from 9.15 to 17.98 and contains micronutrients like Sodium (Na), Calcium (Ca), Zinc (Zn), Sulphur (S), Magnesium (Mg) and Iron (Fe). Vermicompost provides all nutrients in readily available form and enhances uptake of nutrients by plants. It improves soil structure, texture, aeration and water holding capacity and prevents soil erosion.

On the other hand, neither inorganic fertilizers nor organic manures alone can improve soil health and productivity. The positive effect of judicious use of organic and inorganic fertilizers on productivity of crops and soil fertility has been reported by many workers (Baishya*et al.*, 2015; Singh *et al*., 2015 and Kundu*et al*., 2016). However, little information is available on suitable combination of vermicompost with chemical fertilizer on the soil fertility, plant growth and yield of component crops in Wheat-T. aus - T. aman cropping patterns. Therefore, the present study was under taken (1) to find out a suitable combination of vermicompost with chemical fertilizers for growth and yield of crops and (2) to sustain the soil fertility and productivity.

6. Procedure/Methods : **Crop:** Wheat, T. Aus and T. Aman
Variety: Wheat var. BARI Gom 30, T. Aus var. BRRI dhan-48, T. Aman var. BRRI dhan-49
Treatments:
T_1 = STB Chemical fertilizers
T_2 = IPNS with 5 t ha^{-1} cowdung based on T_1
T_3 = IPNS with 3 t ha^{-1} poultry manure based on T_1
T_4 = IPNS with 1.0 t ha^{-1} vermicompost based on T_1
T_5 = IPNS with 2.0 t ha^{-1} vermicompost based on T_1
T_6 = IPNS with 4.0 t ha^{-1} vermicompost based on T_1

T_7 = Native fertility/control
Design: RCB with three replications
Plot size: 4 m x 4 m
Fertilizers: As per FRG 2012
Data to be recorded:
Dates of all operation
Soil properties
Yield and yield contributing characters
Major disease and insect incidence

7. Investigator(s) : M.M. Bazzaz, A. Hossain, M.A.Z. Sarker, M.N. Alam and M. Bodruzzaman
8. Season : 2020-2021
9. Date of Initiation : November 2020
10. Date of completion April 2021
11. Exp. Output/Benefit : Soil fertility and productivity will be increased by using vermicompost. The wheat yield will be increased 10-15% and the production will be economically profitable.
12. Locations : BWMRI, Dinajpur
13. Status : New
14. Estimated Cost : 50,000/-
15. Source of Fund : BWMRI
16. Priority :
17. Remarks :

1. Programme : Wheat and Maize Improvement
2. Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.2 : Wheat-Maize System
3. Plan/Expt. 3.1.2.1 : **Evaluation of different herbicides to control weeds in maize field**
Objective (s) : 1. To find out a suitable herbicide for Maize
2. To determine the efficiency of different herbicides

Rationale /justification : Maize (*Zea mays*) stands third in position of consumption among cereal crops in Bangladesh. Hybrid maize has been introduced in Bangladesh due to its yield potentiality, therefore the area and production of hybrid maize is increasing day by day in Bangladesh. Although the potential yield of hybrid maize is high but the yield is lower at farmer's field. Among many reasons, weeds are one of the most important responsible factors limiting maize production in Bangladesh. Weeds cause enormous losses to crops even more than other pest worldwide that on an average, 37.3% of crop produce is damaged if weeds are not controlled in Bangladesh. Weed infestation caused 12.8 to 29.2% yield loss in maize. Therefore, weeding should be done to ensure optimum grain yield. Moreover, during *kharif* (dry) season weeds grow vigorously and compete with the crop for nutrients, space and solar radiation resulting in yield reduction. So, weed management may help in reducing the crop weed competition and increase opportunity for plant to absorb more nutrients. Thus weed control at proper stage improve the productivity.

Weed control in maize is carried out by mechanical and/or chemical methods. Although both methods are effective in controlling weeds but they increase production costs and have some disadvantages or side effects when applied intensively. Therefore this experiment was carried out to find out the proper agronomic management along with both pre and post emergence herbicides to reduce the costs and risks

of intensive weed control in maize field.

Materials and Methods

Crop : Maize

Variety : BARI Hybrid Maize 16

Treatments :
1. Calaris Xtra 27.5 SC @ 6 ml/L
2. G-Maize 50 Sc @ 5 ml/L
3. Joankana @ 5 ml/L
4. Triojin 55 SC @ 4 ml/L
5. Zin Force 80% WFP @ 4 g/L
6. Hand weeding at 25 DAS
7. Weedy check/control

Design : RCB

Replications : 3

Unit plot size : 4 m x 4 m

Fertilizer dose : FRG'12 Recommended dose

Data to be collected : No. of different weed species (broadleaf, sedge and grass), fresh and dry wt./m^2 of different weed species, WCE (%), yield and yield attributes of wheat and economic performance

Expected output : A suitable herbicide will be identified to control weeds for increasing maize yield and quality

Status : New

Date of initiation : November 2020

Date of completion : May 2021

Estimated cost : Tk. 30,000/-

Source of fund : BWMRI

Location(s) : BWMRI, Dinajpur

Investigator(s) : M.M. Bazzaz, M.A.Z. Sarker, A. Hossain and M.M. Akhtar

Programme : Wheat and Maize Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.2 : **Wheat-Maize System**

Expt. 3.1.2.2 : **Development of Fertilizer Recommendation for Hybrid Maize in Kharif Season**

Objective :
i. To find out the optimum and economic fertilizer dose for kharif maize
ii. To sustain the soil fertility and productivity

Rationale : In Bangladesh, hybrid maize is grown mostly in Rabi season during November-April. Recently, the area of Kharif-I (March-June) maize, mainly after the harvest of potato, is increasing. Most of the farmers grow hybrid maize with improper fertilization in Kharif season. As a result, maize yield varies from one farmer to another. FRG'12 mention that fertilizer dose of Rabi maize can be reduced by 30% when the crop is grown in Kharif season. But farmers who are using higher doses of fertilizer, harvest higher maize yield. However, the highest productivity of maize in sustainable manner without deteriorating the soil and other natural resources could be achieved only by applying appropriate combination of organic and inorganic fertilizers. Therefore, the trial is under taken to determine the nutrient requirement in hybrid maize during Kharif Season.

Procedure/Methods : **Crop : Maize**
Variety: BARI Hybrid maize 9
Treatments:
T_1 = STB Chemical fertilizer dose for Rabi
T_2 = 85% of T_1 + cowdung 5 t ha^{-1}
T_3 = 70% of T_1 + cowdung 5 t ha^{-1}
T_4 = IPNS of T_2 with 5 t ha^{-1} cowdung
T_5 = IPNS of T_3 with 5 t ha^{-1} cowdung
T_6 = IPNS of T_1 with 5 t ha^{-1} cowdung
Design: RCB
Replications: 3
Unit Plot size: 3 × 4 m
Spacing: 60 cm x 20 cm
Fertilizer dose and
Application method: As per treatment
Data to be collected: Soil properties, yield and yield contributing attributes, economic performance, disease and insect infestation

Investigator(s) : M.M. Akhtar, A. Hossain, M.M. Bazzaz, M.A.Z. Sarker and M. Bodruzzaman

Season Kharif season 2019-2022

Date of initiation : April, 2019

Date of completion : July, 2022

Expected output : Economic fertilizer dose for kharif hybrid maize will be identified. Maize yield will be increased.

Location (s) : BWMRI, Dinajpur

Status On- going

Estimated cost : 60,000/-

Source of fund : BWMRI

Priority : 1

Programme : Wheat and Maize Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.2 : **Wheat-Maize System**

Expt. 3.1.2.3 : **Response of Maize–Legume Intercropping as Push–Pull Technique to Control Fall Armyworm**

Objective : To evaluate the effects of maize-edible legume intercropping systems with push-pull technology (PPT) to control Fall Armyworm (FAW)

Rationale : Maize production is constrained by combinations of poor mineral nutrition (Gunes et al. 2007) and insect pests (Chabi-Olaye et al. 2005; Tavares,et al. 2010). Recent emergence of the invasive FAW *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in Africa has overshadowed the stem borer *Busseola fusca* (Lepidoptera: Noctuidae) as the major insect pest of maize (Chabi-Olaye et al. 2005; Stokstad et al. 2017). A holistic approach is, therefore, necessary for the control of pest in maize fields that integrates sustainable management strategies. Intercropping system is one of the potential sustainable pest management strategies which constitutes push-pull systems involving companion plants that act as the "push" component for pests, or planting companion plants at the boarders of main crops to act as the "pull" component (Cock et al. 2007; Khan et al. 2007; Midega et al. 2018). Some companion plants release semiochemicals that either repel insect pests from the main crop (e.g., push system) or attract insect pests away

from the main crop (e.g., pull system) by providing better niches and food resources (Khan et al. 2010). The cultivation of grain legumes as companion crop can provide a different ecological niche for the FAW larvae while also emitting semiochemicals that may deter FAW and oviposition (Ndakidemi et al. 2016). Legume intercropping is widely encouraged as a viable integrated soil fertility management strategy (Proctor et al. 2007; Vanlauwe et al. 2010) as legumes can also serve as a push factor against insect pests (Khan et al. 2010; Midega et al. 2018). There, this study is undertaken as an observational trial to evaluate the effects of selected maize-edible legume intercropping systems over PPT and sole maize for management of FAW and to compare efficacy for sustainable crop maize production.

Procedure/Methods : **Crop:** Maize
Variety: BARI Hybrid Maize 16
Design: RCB with 3 replications
Treatments:
T_1 = Maize - Mung Bean intercropping
T_2 = Maize - Black Gram intercropping
T_3 = Maize - Groundnut intercropping
T_4 = Maize - Desmodium spp. intercropping
T_5 = Sole Maize and
Napier Grass should be sown surrounding the all unit plot except Sole Maize treatment
Unit Plot size: 7.8 × 6.8 m
Spacing: Maize: 60 cm x 20 cm
Legume: 1 row in between two Maize row
Fertilizer dose and
Application method: As per BWMRI recommendation
Data to be collected: Soil properties before and after experimentation, yield and yield contributing attributes of Maize, yield of Legume crop and Napier Grass, FAW infestation on Maize plant and cob.

Investigator(s) : M.M. Akhter, M.M.R. Shah, A. Ahmed, A. Hossain, M.M. Bazzaz and M.A.Z. Sarker and M. Bodruzzaman

Season : Late Rabi

Date of initiation : January, 2020

Date of completion : May, 2022

Expected output : **i)** Agronomic management practices will be develop to control FAW on Maize
ii)To increase crop productivity economically with maintaining soil fertility

Location (s) : BWMRI, Dinajpur

Status : New/observation trial

Estimated cost : **70000/-**

Source of fund : BWMRI, Dinajpur

Priority : **1**

1. Programme : Wheat and Maize Improvement

2. Project 3 : Crop and Soil Management

3. Sub-Project 3.1 : Crop Management

4. Sub-Sub-Project 3.1.3 : **Physiological Studies**

5. Experiment 3.1.3.1 : **Study the performance of some selected wheat genotypes in southern Bangladesh**

6. Objective(s) : To observe the yield performance of wheat genotypes in saline soils

Rationale : Wheat is the second most important grain crop after rice in Bangladesh grown over an area of about 0.43 million hectares with an annual

production of about 1.4 million metric tons which is much less than that of country's need of 5.5 million metric tons. To fulfill current and future demand it is essential to improve wheat productivity and production. Now-a-days, the scope of expanding wheat in traditional area is very limited due to competition with other crops at rabi season. So wheat has to be expanded in non-traditional area. A vast non-traditional area nearly 0.84 million hectares remains fallow in winter in southern Bangladesh affected by varying intensities of salinity. Some part of that non-traditional area may be brought under wheat cultivation at rabi season. Introduction of salt tolerant wheat varieties for overcoming the salinity problem has been considered the most feasible and economic than management and it has recently received much attention. Screening is the most important procedure to find out the salt tolerant genotypes of crops from available germplasm and this screening under field condition is more appropriate because of facing more heterogeneous soil conditions by crops under filed situation.

Materials and methods : Three trials will be conducted in three locations.

Crop/genotype : Crop- Wheat, Genotypes-20

Design : 4 x 5 RCB

Plot size : 2.5m x 0.8m

Planting system/spacing : Line sowing. Row to row distance 20 cm

Fertilizer dose and methods of application : BARI- recommended

Irrigated/rainfed : Irrigated

Data to be recorded : Salinity monitoring, phenology, growth, yield and yield attributes

Investigator(s) : MM Khan, G. Faruq, MM Rahman and M Israil Hossain

Season : Rabi, 2020-2021

Date of Initiation : November, 2020

Date of completion : March, 2021

Expt. output/benefit : Selected genotype will help in salt tolerant variety development

Location : 3 (Patuakhali; Khulna and Satkhira)

Status : On-going (4th year)

Estimated cost : 1,50,000/-

Source of fund : BWMRI

Priority : 1

Programme : Wheat and Maize Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.3 : Physiological Studies

Experiment 3.1.3.2 : **Response of newly evolved wheat varieties to sowing dates**

Objective(s) :
i. To examine the impact of inter- and intra- seasonal temperature variation on wheat performance stability
ii. To identify suitable wheat genotypes for appropriate sowing dates considering agronomic performance, yield response, disease incidence, etc.

Rationale : In Bangladesh, wheat is ranked as the second most important cereal after rice and plays an important role in meeting the country's target of achieving food security for an ever-increasing population (Timsina et al., 2016). It is grown in large areas of 130,768 ha in 2015-16 in the North-Western part of Bangladesh (BBS, 2016). According to the report of BBS (2016), 1.35 million tons of wheat was harvested from

0.44 million ha in 2015-16, of which 30.65% was in Northern Bangladesh (or Old Himalayan Piedmont Plain only). However, average yield of wheat was only 3.03 t h^{-1} in 2015-16 (BBS, 2016), compared to the global average wheat yield (3.07 t ha^{-1}) for the same year (Statista, 2016).

Optimum seeding time is considered to be an important management strategy for improving wheat grain yield (Hossain and Teixeira da Silva, 2012). This is particularly important because it is under the control of farmers (Slafer and Satorre, 1991; Laghari*et al*., 2011). Optimum time for sowing of wheat in Bangladesh is between mid-November and first week of December (Hossain and Teixeira da Silva, 2012), due to its own definite requirements for temperature and light for emergence, growth and flowering (Hossain *et al*., 2013). But, about 85% of the total wheat area follows previous rice crop (Saunders, 1991) and over 60% of the total wheat crop is cultivated at late sowing conditions (Badruddin*et al*., 1994). In the north-western part of the country, where high lands generally remain fallow after aus rice or jute cultivation, seeding of wheat can be done in early November (which can induce early sowing heat stress condition). In some areas where wheat is followed by transplant aman rice or soil remains wet due to excessive rainfall, seeding is continued up to January (terminal heat stress condition) (BARI 2013).

Too early sowing can produce weak plants with poor root systems. Temperature above optimum leads to irregular germination and the embryo frequently dies and the endosperm may undergo decomposition due to activities of bacteria or fungi. In late planting, the wheat variety should be short duration that may escape from high temperature at the grain filling stage (Phadnawis and Saini, 1992). Ansary*et al.* (1989) reported that a delay in sowing suppressed yield, caused by reduction in the yield contributing traits like number of tillers, number of grains $spike^{-1}$ and grain yield. Rajput and Verma (1994) observed that normal sowing gave higher grain yield than late sowing. Early sowing always produces higher yield than late sowing. Each day delay in sowing from 20th November decreases grain yield @ 39 kg ha^{-1} per day (Singh and Uttam 1999). Ahmed (1986) also reported that about 1.3% reductions in day of December. The adverse effect of temperature could be minimized by adjusting sowing time to an optimum date and to find out heat tolerant genotypes, which are suitable for late and very early sown conditions to ensure high grain yield.

Recently, some advanced wheat genotypes were released as varieties by Wheat Research Center of Bangladesh Agricultural Research Institute. These varieties were developed for optimum as well as late sown conditions, i.e., these genotypes have some heat tolerant characteristics (BARI, 2016). The newly developed varieties need to be evaluated for their agronomic performance under different environmental conditions. Therefore, the present study was undertaken to evaluate the performance of newly released varieties under different high temperature stress in early and late sown conditions, to find out the suitable variety for optimum and late sown condition, to find out heat tolerant and heat sensitive variety and to find out the optimum sowing time for a specific variety.

Materials and methods **:**

Crop/genotype **:** Six wheat genotypes

Design : Split-Plot design with 3 Replications
Main plots: 5 Sowing dates.
Nov. 25, Dec. 05, Dec. 15, Dec. 25 & Jan. 04
Sub plots: 7 Wheat Genotypes.
BARI Gom 26, BARI Gom 30, BARI Gom 31, BARI Gom 32, BARI Gom 33, WMRI 1, WMRI 3

Plot size : **3x2 m (3m long 10 rows) (6 m^2 each sub plot)**

Planting system/spacing : Seeds will be sown continuously at 120 kg ha^{-1} except BARI Gom 33 (140 kg ha^{-1}) with 20 cm row to row distance.

Fertilizer dose and methods of application : Fertilizers will be applied at doses recommended by theBARI: 100-27-40-20-1 kg ha^{-1} of N (nitrogen)-P (phosphorus)-K (potassium)-S (sulphur)-B (boron). Two-thirds of N and a full amount of the other fertilizers will be applied as a basal in final land preparation. The remaining N fertilizer will be applied immediately before the first irrigation {17-21 days after sowing (DAS)}.

Irrigated/rainfed : 3 light irrigations: first irrigation at 17-21 DAS (at crown root initiation), Second and third irrigations will be applied at booting (50-55 DAS) and grain-filling (70-75 DAS) stages.

Data to be recorded :

(1) Previous crop history as well as record (kg/m^{-2}) residue of previous crop

(2) Soil properties, soil nutrient status (before sowing and after harvesting) and moisture status immediately sowing.

(3) **Key phenology dates:** sowing, emergence, crown root initiation, first tiller, booting, flowering/anthesis and physiological maturity

(4) Initial plant population at 12 DAS (80% emergence) as well as tillers m^{-2} at 30 & 45 DAS: These data will be recorded from 1m long 5 marked rows in every plot.

(5) **Biomass cut:**

- 1 m^2 at mid-vegetative, booting/awn-peep stage, anthesis and physiological maturity stage (kg/ha total)
- Mass stems, leaves, storage organs, roots (dead & live)
- Stem number/tillers count
- LAI

(6) **Yield and yield attributes:** Crop will be harvested plot-wise at full maturity while sample plants will be harvested separately. The harvested crop of each plot will be bundled separately, tagged and threshed on a threshing floor after thoroughly drying the bundles in bright sunshine and weighing them.

Then, data on plant height (cm), spikes m^{-2}, spikelets $spike^{-1}$, grains $spike^{-1}$, 1000-grain weight (g), grain and biomass yield (t ha^{-1}), harvest index (%) will be recorded. To obtain the actual yield of all varieties, grain yield and 1000-grain weight will be adjusted at 12% moisture.

General comments:

1. Management like seed rate, seed source, sowing time, fertilizers rate and application methods, amount of irrigation and time of irrigation, weed management should same for all locations.
2. We have to record/collect pedigree of all genotypes
3. Daily weather data like max and min temperature, rainfall, humidity and sunshine hrs. We have to collect historical weather data (about 30 yrs) for simulation analysis.
4. We have to ensure leaf area meter for LAI and oven for dry biomass

5. For APSIM modeling, we need N data as $NO3^-$ (wet condition) and $NH4^+$ (dry cultivation like wheat)
6.

Investigator(s) : Akbar Hossain, Tim Krupnik (CIMMYT), MAZ Sarker& M. Israil Hossain (BARI, Dinajpur); MI Hossain, AA Khan (RBARI, Rajshahi), Rabiul Islam, Babul Anwar, MS Islam (RARS Jessore)

Season : Rabi, 2019-2020 (with Aman crop management to follow in the next protocol)

Date of Initiation : November, 2020

Date of completion : March, 2021

Expt. output/benefit : Updated data on yield decline rates with different varieties as a function of sowing date. This trial will also permit advanced G × E × M analysis. This information will help to plan new research program for developing wheat varieties, which are able to produce adequate and stable yield under varying climatic conditions with minimum or no disease infection.

Location : BWMRI, Dinajpur; RWRC-BWMRI, Rajshahi; RARS, Jessore

Status : On-going (4^{th} year)

Estimated cost : 7,50,000/- (2,50,000/-/per location per year, including Aman crop)

Source of fund : CIMMYT-CSRD/BWMRI

Priority : 1

Programme : Wheat and Maize Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.3 : Physiological Studies

Experiment 3.1.3.3 : **Evaluation of wheat genotypes against salinity at seedling stage**

Objective(s) : To select the wheat genotypes tolerant to salinity

Rationale : Salinity is one of the major limitations to wheat production worldwide including southern Bangladesh. Salinity stress exerts a negative influence on wheat production and reduces the yield (Ghane *et al*. 2011; Parida and Das, 2005). There is a lot of demand for wheat in Bangladesh and increasing day by day but production is very low compared to demand. According to BBS (2016), against the demand of around 6.0 MT, wheat production is only about 1.35 million MT in Bangladesh. Therefore the production needs to be increased to meet the current and future demand. Now-a-days, the scope of expanding wheat in traditional area is very limited due to compete with other crops at rabi season (Rafiq *et al.* 2005). So, to increase wheat production, we have to go to non-traditional areas. A vast area nearly 0.84 million hectares cultivable land remains fallow in rabi dry season in southern Bangladesh affected by varying intensities of salinity (Karim *et al*., 1990). Rainfed dry season cropping in such lands is dominated by the pulses, nonetheless where limited irrigation is possible, wheat cultivation is profitable low risk option. Therefore, we need salt tolerant wheat varities for overcoming the salinity problem for wheat cultivation which has been considered the most feasible and economic. Wheat is moderately salt tolerant crop (Maas and Hoffmann, 1977; Munns*et al*., 2006) and salt tolerance in wheat may vary with the growth stages (Kingsbury and Epstein, 1984; El-Hendawy*et al*., 2005) and also it is reported that seedling stage is less tolerant against salinity among the growth stages (Maas and Poss, 1989). Screening is the most important procedure to find out the salt tolerant genotypes of crops from available huge germplasms at seedling stage under laboratory condition than field condition. Then

we can go for fine tuning against salinity in adaptive trial in coastal region with selected materials from this laboratory trial. Therefore, comparison of large number of genotypes for seedling growth can provide useful information about the salt tolerance potential of screened material which will be useful for breeding salt tolerant cultivar or introducing the screened material for cultivation on salt-affected soils.

Materials and methods : Seedlings will be grown in hydroponic system. Seawater will be used as salt solution

Crop/genotype : Crop- Wheat, Genotypes-100

Design : Factorial CRD Replication: 4 Treatment: 2

Salinity level:

i. Tap water (Control)
ii. 15 dS m^{-1}

Saline water used will be diluted from sea water

Plot size : N/A

Planting system/spacing : N/A

Fertilizer dose and methods of application : Nutrient application through Hoagland solution

Irrigated/rainfed : N/A

Data to be recorded : Germination percentage, Shoot & Root length, Shoot fresh weight, Shoot & Root dry weight, Na and K concentration in root and shoot

Investigator(s) : M.M. Khan, G. Faruq, M.M. Rahman and M.I. Hossain

Season : Rabi, 2020-21

Date of Initiation : November, 2020

Date of completion : March, 2021

Expt. output/benefit : Selected genotype will help in salt tolerant variety development

Location : RS, BWMRI, Joydebpur, Gazipur

Status : On-going (5^{th} year)

Estimated cost : 50,000/-

Source of fund : BWMRI

Priority : 1

Programme : Wheat and Maize Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.3 : Rice-Wheat System

Plan/Expt. 3.1.3.4 : **Determination of seed rate of wheat for late sown condition**

Objective : To find out the optimum seed rate for late sown condition of wheat

Rationale : Wheat (*Triticum aestivum* L.) is the foremost among cereals and stands first globally in terms of production and acreage (FAO, 2016). However, the average yield of wheat (3.08 t ha^{-1}) in Bangladesh is lower than other wheat-growing countries like Egypt (5.10 t ha-1), around the world (FAOSTAT, 2016). The potential yield of wheat varieties is 4.0 to 5.5 t ha-1 but in farmers' fields (national average) it is 3.49 t ha^{-1} (BWMRI, 2019). The reason for this gap in yield between farmers' and research fields is the lack of awareness among farmers about the use of proper agronomic management involving variety, sowing time, seed rate, balanced dose of fertilizers and other factors associated with crop production. Among them seed rate along with varying seed size is the most important agronomic practice which significantly influenced the grain yield of wheat (Sarker et al., 2007.A

		common seed rate of 120 kg ha^{-1} is used for all the varieties under normal sowing time (Razzaque et al., 2000; Islam et al., 2004). But farmers are using higher seed rate, sometimes even double of the recommendation for controlling weed, repelling birds and expecting higher yield. Hence, optimum seeding rate is considered to be an important management strategy for maximize yield. Considering the above facts, the present study was, therefore, selected to evaluate the various seeding rates of recently developed wheat variety under late sown condition, and to determine optimum seed rates for reducing production costs and achieving higher grain yield under late sown condition.
Procedure/Methods	**:**	**Crop:** Wheat **Variety:** BARI Gom 32 and WMRI Gom 1 **Design:** Split-Split- plot with 3 replications **Treatments:** **Factor A: Main plot:** Sowing date: 30 Nov., 15 Dec. and 30 Dec. **Factor B: Sub plot:** Two wheat varieties **Factor C: Sub-sub- plot:** Seed rate: 120 and 140 kg ha^{-1} **Unit plot size:** 4 × 3 m Fertilizers: Recommended fertilizer by BWMRI will be applied **Data to be recorded:** 1. Initial plant population 2. Number of tiller at different growth stages 3. Dry matter at different growth stages 4. SPAD value and Canopy Temperature Depression (CTD) at different stages 5. Phenological parameters and 6. Yield and yield contributing characters
Investigator(s)	**:**	M.M. Akhter, A. Hossain, M. M. Bazzaz and M.A.Z. Sarker
Season	**:**	*Rabi*, 2019-20 to 2020-22
Date of Initiation	**:**	November, 2019
Date of completion		April, 2022
Exp. Output/Benefit	**:**	Farmers are using higher seed rates for late sown wheat cultivation. After the study they can get optimum seed rate which will reduce their cost of cultivation.
Locations	**:**	BWMRI, Nashipur, Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 75,000/-
Source of Fund	**:**	BWMRI, Dinajpur
Priority	**:**	1
Remarks	**:**	

SUB-PROJECT 3.2: SOIL MANAGEMENT

Program	**:**	Wheat and Maize Improvement
Project 3	**:**	Crop and Soil Management
Sub-Project 3.2	**:**	Soil Management
Plan/Expt. 3.2.1	**:**	**Effect of different doses of vermicompost in combination with chemical fertilizers in a Wheat-Maize-T. aman rice cropping pattern**
Objective(s)	**:**	Evaluating the impact of different doses of vermicompost with chemical fertilizers on crop growth and yield.
Rationale	**:**	Nutrient management to boost up crop production should be economically viable, environmental friendly and socially acceptable without affecting the gross production. The organic manure is an eco-friendly, economically viable and ecologically sound source of nutrient that had potentials in improving physical, chemical and biological phenomena of soil. Each year, human, livestock and crops produce

approximately 38 billion metric tons of organic waste worldwide, which may be an efficient source of organic matter supply in soils. According to a conservative estimation, around 600 to 700 million tons (mt) of agricultural waste (including 272 million tons of crop residues) are available in Bangladesh every year, but most of it remains unutilized. This huge quantity of wastes can be converted into nutrient rich vermicompost for sustainable land restoration practices. The earthworm-processed organic wastes, often referred to as vermicompost, are finely divided peat-like materials with high porosity, aeration, drainage, and water holding capacity. Vermicompost may have potentials as a source of nutrients for field crops if applied in suitable ratios with synthetic fertilizers. Thus the objective of the study is to evaluate the impact of different dozes of vermicompost with chemical fertilizers on growth and yield of wheat and potato.

Materials/Methods :

Crop/variety : Wheat (BARI Gom 30), Maize (BARI Hybrid Maize 13/14) and T. Aman rice (BRRI Dhan 75).

Design : RCB

i) Treatments : **8 (Eight)**

1. Absolute control
2. 75% of STB
3. 100% of STB
4. 125% of STB
5. IPNS (2.5 t ha^{-1} vermicompost+ Chemical Fertilizer)
6. IPNS (5 t ha^{-1} vermicompost+ Chemical Fertilizer)
7. IPNS to 125% of STB (2.5 t ha^{-1} vermicompost+ Chemical Fertilizer)
8. IPNS to 125% of STB (5 t ha^{-1} vermicompost+ Chemical Fertilizer)

ii) Replication : 3 (Three)

Plot size : 4m x 5m

Planting system/spacing : Wheat- Continuous seeding in line, Line spacing- 20 cm; Maize- Planting in lime, line to line distance- 60 cm, plant to plant distance-15 cm and Rice- Planting in line, line to line distance- 20 cm and plant to plant distance-15 cm.

Fertilizer dose and methods of application : 100:27:50:20:04 NPKSZn kg ha^{-1} for wheat, 200:50:100:40:04:02 NPKSZnB kg ha^{-1} for maize and 100:10:39:20:03 NPKSZn kg ha^{-1} for rice. Broadcast as basal and top-dress. Broadcast as basal and top-dress.

Irrigated/rainfed : Irrigated

Data to be collected : Soil will be collected initially and after each crop harvest will from individual treatment and analyzed for pH, OM, N, P, K S, Zn, and B. Plant and grain samples will be collected and analyzed for N, P, K, S, Zn and B. Date of emergence and plant population, Yield and yield attributes.

Investigators : SMM Alam, M Bodruzzaman, and MI Hossain

Season : 2020-2021

Date of Initiation : November 2020

Date of completion : April 2021

Exp. Output/Benefit : Soil fertility will be improved and crop yield will be increased.

Location : RBARI, Rajshahi

Status : 2nd year

Estimated Cost : Tk. 75,000/-

Source of Fund : BWMRI/BARI

Priority : 1st

PROJECT 4: PEST MANAGEMENT

SUB-PROJECT 4.1: DISEASE MANAGEMENT

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.1	**:**	**Evaluation of wheat germplasm against Bipolaris leaf blight under field condition**
Objective(s)	**:**	To find out resistant/tolerant lines of wheat against Bipolaris leaf blight under natural disease development.
Rationale	**:**	Bipolaris leaf blight (BpLB) caused by *Bipolaris sorokiniana* is the most important disease of wheat in Bangladesh. Searching for resistance is a continuous process towards development of resistant varieties. High degree of resistance to BpLB disease is not available in the existing cultivars. It is, therefore, essential to screen available germplasms from different sources of diverse genetic background including materials derived from wide-crosses.
Materials and Methods	**:**	About 140 germplasm from different sources of home and abroad along with local and international checks will be evaluated for their response to BpLB under field conditions. The materials will be sown in 2.5m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The nursery will be surrounded by spreader rows of susceptible varieties. Data on BpLB severity will be recorded three times at Zadok's GS 69-71, 73-75 and 77-83 following double- digit scale (00-99) and AUDPC will be calculated. Data on agronomic characters including thousand grain weight and grain yield will also be recorded.
Investigators	**:**	MM Hossain, MMA Reza, K Mustarin, KK Roy, MME Rahman and B Anwar
Season	**:**	2020-2021
Date of Initiation	**:**	November 2020
Exp. Output/Benefit	**:**	BpLB resistant/tolerant lines will be identified for using in the crossing block in order to incorporate resistance/tolerance in widely adapted high yielding varieties.
Locations	**:**	Dinajpur, Jamalpur and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 2,30,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.2	**:**	**Evaluation of wheat genotypes for resistance to Bipolaris leaf blight under inoculated condition**
Objective(s)	**:**	To evaluate adult plant resistance of wheat genotypes against Bipolaris leaf blight under induced disease pressure.
Rationale	**:**	Bipolaris leaf blight caused by *Bipolaris sorokiniana* is the most economically important disease of wheat in Bangladesh. No absolute resistance against this disease is available in the existing germplasm. Lines showing resistance at seedling stage may be susceptible at adult plant stage. Therefore, it is necessary to screen wheat lines against BpLB at adult plant stage under induced disease pressure in the field.
Materials and Methods	**:**	Fifty six lines of wheat will be sown in 1m long 2-row plots. Inoculum will be grown on PDA media and 10^4 conidia/ml of suspension will be sprayed after heading stage. The plants will be incubated under polythene cover for 48 hours. Data on disease severity will be recorded as % Diseased Leaf Area (DLA) on flag leaves of 10 main tillers at 20-25 days after inoculation following standard scale. Lines will be graded into different resistance categories based on % DLA.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Resistant/tolerant lines will be found out in order to develop increased diversity of BpLB resistance.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 80,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.3	**:**	**Evaluation of wheat genotypes for resistance to leaf rust under inoculated condition**
Objective(s)	**:**	To evaluate adult plant resistance of wheat genotypes against leaf rust under induced disease pressure.
Rationale	**:**	Leaf rust caused by *Puccinia triticina* is one the major constraints to sustainable production of wheat in Bangladesh. It may cause significant yield loss under favourable conditions of disease development. Development of resistant varieties is the most economic and safe approach for disease control and to minimize yield losses. Evaluating lines under induced disease epidemic is a pre-requisite for developing resistant varieties. Therefore, it is necessary to screen wheat lines for leaf rust resistance under induced disease pressure.
Materials and Methods	**:**	Seventy advanced and promising wheat lines along with check varieties will be sown in 1m long 2-row plots. Two rows of susceptible variety Morocco will be planted after every two test entries. The nursery will be surrounded by spreader rows of susceptible varieties. The spreader rows as well as the test lines will be inoculated by spraying with aqueous suspension of urediospores at booting stage to develop leaf rust epidemic. Disease severity will be recorded three times at Zadoks' GS 69-71, 73-75 and 77-83 following modified Cobb scale. The lines will be evaluated for resistance based on relative disease severity.
Investigators	**:**	MMA Reza, K Mustarin, KK Roy and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Resistant lines will be found out in order to develop increased diversity of leaf rust resistance.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 60,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.4	**:**	**Efficacy of fungicides in controlling Bipolaris leaf blight of wheat**
Objective(s)	**:**	To evaluate the efficacy of some new fungicides in controlling BpLB of wheat.
Rationale	**:**	Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of BpLB under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole and Propiconazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of some new fungicides in controlling BpLB under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of BpLB of wheat. The fungicides will be sprayed twice at 13-15 days interval commencing from heading stage. The susceptible variety Kanchan will be used for this experiment. The experiment will be carried out in RCB design with three replications. Unit plot size will be 2.5 x 1.2 m. Severity of BpLB will be scored as % DLA from flag leaves of 10 main tillers following standard scale. Agronomic data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling BpLB will be found out and increased grain yield of wheat will be obtained.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.5	**:**	**Efficacy of fungicides in controlling leaf rust of wheat**
Objective(s)	**:**	To evaluate the efficacy of some new fungicides in controlling leaf rust of wheat.
Rationale	**:**	Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of rust under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole and Propiconazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of some new fungicides in controlling leaf rust under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of leaf rust of wheat. The fungicides will be sprayed twice/thrice at 13-15 days interval commencing from first appearance of symptom. The susceptible variety Morocco will be used for this experiment. The experiment will be carried out in the field in RCB design with three replications. Unit plot size will be 2.5m x 1.2m. Severity of leaf rust will be scored from flag leaves of 10 main tillers following modified Cobb scale. Agronomic data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling leaf rust will be found out and increased grain yield of wheat will be obtained.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	:	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.6	:	**Adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight**
Objective(s)	:	1. To assess the individual and combined effects of terminal heat stress and Bipolaris leaf blight on selected wheat genotypes. 2. To identify genotypes having tolerance to terminal heat stress and Bipolaris leaf blight.
Rationale	:	High temperature prevailing during grain filling period is one of the most important abiotic constraints for sustainable wheat yield in Bangladesh. The increasing temperature after anthesis also favours rapid development and spread of Bipolaris leaf blight that causes significant yield losses. Variability in level of tolerance to heat stress and severity of BpLB exists among different wheat genotypes. Therefore, it is essential to find out genotypes with good level of tolerance to both the stresses in order to improve wheat yield, particularly under late sown condition.
Materials and Methods	:	The experiment will be conducted in Split-split-plot design with two replications. Main plot: 2 sowing dates (Nov. 20-25 & Dec. 20-25), Sub-plot: 2 fungicide protections, and Sub-sub-plot: 12 genotypes including check varieties. Unit plot size will be 2.5m x 1.2m (2.5 m long 6 rows with 20 cm spacing. Disease notes will be recorded 3 times at Zadok's GS 69-71, 73-75 and 77-83 on double digit (00-99) scale, converted to % DLA and AUDPC was calculated. Data on early ground-cover, stay green score, leaf tip necrosis, canopy temperature, biomass, yield and yield components will be recorded.
Investigators	:	KK Roy, MME Rahman, K Mustarin and MMA Reza
Season	:	2020-2021
Date of Initiation	:	November- 2020
Expt. Output/Benefit	:	Individual and combined effects of heat-stress and BpLB and their interactions with different wheat genotypes will be assessed. Adapted genotypes will be identified and relationships between different traits determined.
Locations	:	Dinajpur
Status	:	On-going
Estimated Cost	:	Tk. 75,000/-
Source of Fund		BWMRI
Priority	:	1
Remarks	:	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.7	**:**	**Monitoring and evaluation in international wheat disease nurseries**
Objective(s)	**:**	1) To identify diseases, track pathogens and assess disease severity. 2) To identify and select sources of resistance. 3) To collaborate with the international partners developing global disease management strategies.
Rationale	**:**	The occurrence and severity of different diseases may vary from location to location and year to year at national and global level depending on environmental conditions. A major disease may become minor and a minor disease may become major because of change in cropping systems, cultural practices, crop varieties and environments. Moreover, new diseases may also appear in different localities, particularly under changed climate. Therefore, regular monitoring and evaluation in different international disease nurseries is essential to know the existing disease situation in the country and finding new sources of resistance.
Materials and Methods	**:**	Different disease nurseries including specific disease nurseries will be received mainly from CIMMYT. The nurseries will be set up in different 'hot-spot' locations as per the plan supplied for respective nurseries. Normally the entries will be sown in 2.5 m long 2 row-plots with 20 cm spacing. The spreader rows of susceptible varieties will be planted surrounding the nurseries. Recommended agronomic practices will be followed for normal plant growth. Disease notes will be recorded according to standard disease scoring scales. Wherever required, agronomic data will be taken according to the instructions supplied. If any new disease appears, it will be identified locally or the diseased specimen will be sent to specified laboratory for proper identification.
Investigators	**:**	MM Hossain, MMA Reza, K Mustarin, KK Roy, MME Rahman, B Anwar, F Amin and KH Alam.
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Expt. Output/Benefit	**:**	The existing disease situation of wheat in the country will be understood, and new sources of resistance will be found out.
Locations	**:**	Dinajpur, Joydebpur, Jamalpur, Rajshahi and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 4,00,000/-
Source of Fund		BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.8	**:**	**Surveillance of rusts and blast of wheat in Bangladesh**
Objective(s)	**:**	1) To identify rust and blast diseases of wheat, track pathogens and assess disease severity in farmers' fields. 2) To collaborate with the international partners developing global rust and wheat blast management strategies.
Rationale	**:**	Rusts are important diseases of wheat worldwide. The tiny spores of rust pathogens are airborne in nature and can travel long distances often over continents. The virulent stem rust race Ug99 and its variants have posed a serious threat to the important wheat production areas of the Indian subcontinent and beyond. Another most important disease; wheat blast caused by *Pyricularia oryzae* (teliomorph: *Magnaporthe oryzae*) has been identified in Bangladesh for the first time in late February 2016 causing significant yield losses in several south-western and southern districts of the country. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of wheat rust and blast pathogens.
Materials and Methods	**:**	The wheat rust and blast surveillance work will cover farmers' fields and trial sites of the major wheat growing areas of Bangladesh. About 200 fields will be investigated. The survey will be conducted through different stations of BWMRI. Disease assessment will be made following the modified Cobb scale and % spike infection for rust and blast, respectively. The protocols suggested by the BGRI (Borlaug Global Rust Initiative), and CIMMYT will be used during the present survey. Diseased specimens will be collected in brown paper bags and the pathogens will be identified locally or sent to specified laboratory for proper identification and race analysis.
Investigators	**:**	MMA Reza, K Mustarin, MME Rahman, KK Roy, MA Alom, MM Hossain, B Anwar, KH Alam, MF Amin and MR Islam
Season	**:**	2020-2021
Date of Initiation	**:**	February 2021
Expt. Output/Benefit	**:**	The status of the existing rust and blast situation in farmers' fields will be understood for designing proper disease management.
Locations	**:**	Major wheat growing areas of Bangladesh
Status	**:**	On going
Estimated Cost	**:**	Tk. 5,00,000/-
Source of Fund	**:**	BWMRI/ACIAR/KGF
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.9	**:**	**Evaluation of wheat germplasm against wheat blast under field/inoculated condition**
Objective(s)	**:**	To find out resistant/tolerant lines against wheat blast under natural disease development/high disease pressure.
Rationale	**:**	Wheat blast, a devastating wheat disease caused by *Pyricularia oryzae*, teleomorph: *Magnaporthe oryzae*, emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast was first reported in Brazil in 1985 and then in Bolivia, Paraguay, Argentina and Uruguay. Although, wheat blast can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Epidemic years are characterized by several days of continuous rains and average temperature 18-25^{0}C during flowering, followed by sunny, hot and humid days. Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is very essential to screen available germplasm from different sources for resistance to this disease.
Materials and Methods	**:**	About 500 germplasm will be evaluated for their response to wheat blast under field/inoculated conditions. The materials will be sown in 2.5m/1m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The nursery will be surrounded by spreader rows of susceptible varieties. Disease of blast will be recorded based on spike incidence and severity one times at 20-25 days later after heading stage. Data on agronomic characters including thousand grain weight and grain yield will also be recorded.
Investigators	**:**	KK Roy, B Anwar, MMA Reza, K Mustarin and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Wheat blast resistant/tolerant lines will be identified for using in the crossing block in order to incorporate resistance/tolerance in widely adapted high yielding varieties.
Locations	**:**	Dinajpur and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 2,50,000/-
Source of Fund	**:**	BWMRI/KGF
Priority	**:**	1
Remarks	**:**	

Programme	:	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.10	**:**	**Evaluation of elite wheat lines for resistance to blast under inoculated condition**
Objective(s)	**:**	To evaluate advanced wheat lines for resistance to wheat blast under inoculated condition.
Rationale	**:**	Wheat blast, a devastating wheat disease caused by *Pyricularia oryzae*, teleomorph: *Magnaporthe oryzae*, emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast was first reported in Brazil in 1985 and then in Bolivia, Paraguay, Argentina and Uruguay. Although, wheat blast can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Epidemic years are characterized by several days of continuous rains and average temperature 18-25^{0}C during flowering, followed by sunny, hot and humid days. Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is necessary to screen wheat lines against wheat blast under induced disease pressure in the field condition.
Materials and Methods	**:**	About forty (40) elite lines of wheat from different sources will be sown in 1m long 2-row plots. Inoculums' will be grown on OMA media and 20000 conidia/ml of suspension will be sprayed at heading stage. The plants will be incubated in seedling and adult stage. Data on spike incidence and severity will be recorded as % diseased severity on spikes of the whole plot at 20-25 days after inoculation following standard scale. Lines will be graded into different resistance categories based on % disease severity.
Investigators	**:**	KK Roy, MMA Reza, MME Rahman, B Anwar and K Mustarin
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Resistant/tolerant lines will be found out in order to develop increased diversity of wheat blast resistance.
Locations	**:**	Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,00,000/-
Source of Fund	**:**	BWMRI/KGF
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.11	**:**	**Efficacy of foliar fungicides in controlling wheat blast**
Objective(s)	**:**	To evaluate the efficacy of foliar fungicides in controlling wheat blast.
Rationale	**:**	Wheat blast, a devastating wheat disease caused by ascomycetous fungus *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast can occur on all aerial plant parts but most conspicuous symptom is observed on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of wheat blast under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole, Tryfloxystrobin and Trycyclazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of foliar fungicides in controlling wheat blast under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of wheat blast. The fungicides will be sprayed twice at 13-15 days interval commencing from heading stage. The susceptible variety BARI Gom 26 will be used for this experiment. The experiment will be carried out in RCB design with three replications in field conditions. The unit plot size will be 2.5m x 1.2m. Severity of wheat blast will be scored as % from spikes of plot following standard scale. Agronomic data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	B Anwar, KK Roy, MM.A Reza, K Mustarin and MME Rahman
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling wheat blast will be found out.
Locations	**:**	Dinajpur and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 60,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.12	**:**	**Determining status of seed-borne fungi including *Magnaporthe oryzae* pathotype *triticum* causing wheat blast**
Objective(s)	**:**	To determine prevalent seed-borne fungal pathogens along with wheat blast pathogen present in experimental plot seeds from different locations.
Rationale	**:**	Infected or contaminated seeds serve as major source of inoculum for large number of plant pathogens which may infect the seeds and survive as spore or resting structures on or within the seeds (Saberi et al., 2004). Wheat seed harbor several species of fungi, which can reduce seed quality and cause plant disease. Fungi carried on or within seeds reduce seed germination, seedling emergence lead to less vigorous seedling (Anjorin and Mohammed, 2009). Seed-borne fungal pathogen present externally or internally may cause seed abortion, seed rot and seed necrosis (Khanzada et al., 2002). Some plant pathogenic fungi kill seedlings shortly after they emerge, whereas others cause serious disease epidemics after being transmitted from seeds to seedlings. Seed-bone diseases also affect the growth and productivity of wheat (Weber et al., 2001). Seed-borne fungi reported in wheat include *Bipolaris* spp., *Alternaria* spp., *Curvularia* spp. etc. Unfortunately, Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh and also a seed-borne disease. Thus understanding disease epidemiology, its transmission rate and economic threshold, combined with seed health testing in the study areas is very important, as these could help to define the need for seed treatment.
Materials and Methods	**:**	Samples of seeds will be collected from different locations of different varieties of Bangladesh. Disease severity will be recorded following standard scale and the associated fungi will be identified and estimated in blotter method according to ISTA rules.
Investigators	**:**	MME Rahman, K Mustarin , MMA Reza and KK Roy
Season	**:**	2020-2021
Date of Initiation	**:**	May 2021
Exp. Output/Benefit	**:**	The status of seed-borne fungi of wheat will be identified in order to take appropriate control measure for the pathogens associated.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,00,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme : Wheat and Maize Improvement

Project 4 **:** Pest Management

Sub-Project 4.1 : Disease Management

Plan/Expt. 4.1.13 **:** **Molecular detection of wheat blast pathogen *Magnaporthe oryzae* pathotype *triticum* (MoT) collected from different locations of Bangladesh using MoT3 assay and nucleotide sequencing**

Objective(s) **:** To identify and study of the pathogen at genetic level for confirmation of pathotype using molecular tools.

Rationale **:** Wheat blast, an emerging fungal disease caused by *Magnaporthe oryzae* (syn. *Pyricularia oryzae*) pathotype *triticum* (MoT) was first discovered in Brazil in 1985 (lgarashi *et al.* 1986) outside Latin America first incidence of wheat blast was observed in Bangladesh in 2016. Molecular analysis established that the wheat blast observed in Bangladesh was caused by *M. oryzae* pathotype *triticum* (Malaker *et al.* 2016; Islam *et al.* 2016). There are several tools were used for detection of MoT including whole genome sequencing and analysis. Whole genome analysis is costly and not possible in our existing laboratory facilities. However, PCR based assay for MoT specific genes with MoT3 primers developed by Pieck *et al.* (2017) is an easy way to confirm MoT at genetic level. On the other hand, prior to develop management options, as a newly emerged plant pathogen, it is needed to identify and study of the pathogen at genetic level. So, the study has been proposed to standardize a protocol for authentic detection through using molecular tools.

Materials and Methods **:** Infected specimens from different hosts viz. wheat, rice, millet and weed/grass species showing blast symptoms will be collected from different locations of Bangladesh. Diseased plant parts will be separated and isolates will purified by single hyphal tip method using potato dextrose agar (PDA). Then pure cultures of the isolates will characterized up to molecular level at newly established Molecular Laboratory, BWMRI, Dinajpur. For molecular characterization, total DNA will extracted from the isolates separately using Wizard Genomic DNA Purification Kit (Promega, USA). Pathotype specific gene will amplified and determined by using MoT3F and MoT3R primers. The reaction mixtures using Go Tag G2 Green Master Mix (Promega, USA) will incubated in a PCR Thermal Cycler following the programs: initial denaturation at 94°C for 3 min, followed by 30 cycles of denaturation of 94°C for 1 min, annealing at 62°C for 2 min, polymerization at 72°C for 1 min 30 s, and final elongation at 72°C for 10 min. Presence or absence of amplified DNA will be recorded for confirmation of MoT by standard gel electrophoresis protocol. Moreover, DNA from different isolates will be amplified with ITS4 and ITS5 primers and will also be sequenced with same primer set using out sourcing facilities from other laboratory (Malaysia). Sequence data will be analyzed to determine phylogenetic relationships among the isolates.

Investigators **:** MME Rahman, KK Roy, MMA Reza and K Mustarin

Season **:** Year round

Date of Initiation **:** Year round

Exp. Output/Benefit **:** Molecular detection of MoT will standardize and MoT will be confirmed for different isolates collected from different locations.

Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 2,00,000/-
Source of Fund	**:**	BWMRI/KGF
Priority	**:**	1
Remarks	**:**	

Programme	:	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.14	**:**	**Wheat blast: Precision Phenotyping Platform**
Objective(s)	**:**	To screen available germplasms from different sources (national and international) for resistance to this disease.
Rationale	**:**	Wheat blast was first time detected in Asia, following reports of a severe outbreak in Bangladesh (Malaker *et al*. 2016). The disease can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years, warm temperatures and high humidity. The disease can be managed by the use of fungicides, resistant cultivars, agronomic practices and biotechnological methods (Ribot *et al*., 2008). Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is very essential to screen available germplasm from different sources for resistance to this disease.
Materials and Methods	**:**	The experiment will be conducted at RARS, Jashore during 2019-20 crop growing season. A total of around four thousand five hundred entries will be screened against wheat blast under artificially inoculated condition. The materials will be planted in 1m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries with two different dates on 2nd and 3rd week of December 2019.
Investigators	**:**	KK Roy, MR Kabir, MMA Reza, K Mustarin, B Anwar, MME Rahman, R Begum, T Roy and PK Singh
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Resistant lines against wheat blast will be identified.
Locations	**:**	Jashore
Status	**:**	On-going
Estimated Cost	**:**	10,00,000/-
Source of Fund	**:**	CIMMYT/ACIAR/BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	:	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.15	**:**	**Surveillance and monitoring of diseases of Maize in Bangladesh**
Objective(s)	**:**	1. To identify diseases of maize, track pathogens and assess disease severity in farmers' fields 2. To know the status of maize diseases depending on variety and location.
Rationale	**:**	Maize is one of the most important cereal crops in the world and ranks third next to wheat and rice. In Bangladesh, it has a good potential as a cereal crop due to its low cost of production, wide adaptability and diversified use. However, disease might be an important bottleneck for sustainable maize production. Now a days, number of maize diseases is increasing day by day. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of maize pathogens.
Materials and Methods	**:**	The maize survey will cover farmers' fields and trial sites of the major growing areas of Bangladesh. The survey will be conducted through different stations of BWMRI. Disease assessment will be made following standard scale. The protocols suggested by the BGRI (Borlaug Global Rust Initiative), and CIMMYT will be used during the present survey. Diseased specimens will be collected in brown paper bags and the pathogens will be identified locally or sent to specified laboratory for proper identification and race analysis.
Investigators	**:**	MMA Reza, MME Rahman, K Mustarin, KK Roy, MM Hossain, B Anwar, KH Alam and MR Islam
Season	**:**	Year round
Date of Initiation	**:**	Year round
Exp. Output/Benefit	**:**	The status of the existing maize situation in farmers' fields will be understood for designing proper disease management.
Locations	**:**	Major maize growing areas of Bangladesh.
Status	**:**	New
Estimated Cost	**:**	Tk. 3,00,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.16	**:**	**Efficacy of fungicides in controlling leaf blight of maize**
Objective(s)	**:**	To evaluate the efficacy of some new fungicides in controlling leaf blight of maize

Rationale	**:**	Maize is a major multipurpose cereal crop in Bangladesh after rice and wheat. It is planted on an area of 0.55 million hectare with a production of 5.4 million tons. It is used as grain, fodder and for industrial purposes. A large number of pathogenic fungi, bacteria, viruses and insects, infecting maize grain cause combined worldwide annual losses of 9.4%. The fungal diseases of maize includes Turcicum leaf blight, Maydis leaf blight, maize sheath blight, maize rust, Curvularia leaf spot, downy mildew, bacterial stalk rot and cob rot. Among these diseases, leaf diseases can be controlled by using foliar fungicides and seed borne fungi can be controlled by treatment with fungicides by coating. With a view of overall economic significance of maize and its losses the aim of this study is to evaluate some new fungicides in controlling different leaf blight diseases of maize.
Materials and Methods	**:**	Different fungicides will be tested against the leaf blight diseases of maize. The fungicides will be sprayed twice at 13-15 days interval commencing from 4-6 leaf stages age. The experiment will be carried out in RCBD design with three replications. Maize cultivar will be planted on ridges in plots measuring 3.75 m^2. Each plot included 5 m long row, with row to row 0.75 m and plant to plant 0.25 m spacing. Ears from each plant were harvested by hand and grain yield (kg^{-1}) will be recorded on the basis of ear weights by talking estimated shelling percentage of 80% with moisture adjusted to 15%. Severity of diseases will be scored as % DLA following standard scale. Agronomic data will be recorded on plant height (cm), grain yield etc. Percent yield increase over control will be calculated.
Investigators	**:**	K Mustarin, MMA Reza, MME Rahman and KK Roy
Season	**:**	2020-2021
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling different leaf blight diseases of maize will be found out and increased grain yield of maize will be obtained.
Locations	**:**	Dinajpur
Status	**:**	New
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1
Remarks	**:**	

SUB-PROJECT 4.2: INSECT MANAGEMENT

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.1	**:**	Wheat Insects
Experiment 4.2.1.1	**:**	**Survey of insect pests and natural enemies in wheat and determination of damage potential due to insect pests**
Objective(s)	**:**	i. To document the damage severity of insect pests attacking wheat ii To identify the natural enemies of insect pests of wheat
Rationale	**:**	Wheat is the second most important cereal food crop in Bangladesh. The crop is attacked by a number of insect pests both in field and storage. Among the field insect pests, shoot fly, wire worm and aphids are quite serious and may cause considerable yield loss of the crop. Recent reports indicate that insect-pests may be a potential threat for wheat cultivation in near future. Documentation of damage severity of different insect pests along with their peak infestation periods would enable researchers to take initiative managing the pest problems.
Materials and methods	**:**	Different wheat growing areas of the country will be visited at seedling, vegetative, and flowering stages of the crop to collect data on insect pests of wheat and their natural enemies.
Crop/genotype	**:**	Existing wheat crop in the field
Design	**:**	-
Plot size	**:**	-
Planting system/spacing	**:**	-
Fertilizer dose and methods of application	**:**	-
Irrigated/rainfed	**:**	-
Data to be recorded	**:**	1. Percent insect pest infested plants/ m^2. 2. No. of insect pests/ plant or plant parts. 3. Natural enemy population will be recorded.
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	March, 2021
Expt. output/benefit	**:**	Damage severity of insect pests attacking wheat along with their natural enemies will be documented.
Location	**:**	Dinajpur, Thakurgaon, Panchagorh, Rajshahi & Gazipur
Status	**:**	On going
Estimated cost	**:**	Tk. 50,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.1	**:**	Wheat Insects
Experiment 4.2.1.2	**:**	**Yield loss assessment of wheat due to the aphid infestation**
Objective	**:**	To document yield loss due to aphid infestation in wheat

Rationale	**:**	Wheat is the second staple food crop in Bangladesh after rice. At present, consumption of wheat is increasing due to the awareness about the quality food. As a result, wheat cultivation is in increasing trend to satisfy its demand. Recent observation indicates that wheat is attacked by aphid at different growth stages. But still no data or information is available on yield loss due to aphid infestation on wheat in Bangladesh. Therefore, this experiment has been designed to document the yield loss due to aphid infestation on wheat.
Materials and methods	**:**	
Crop/genotype	**:**	Crop: Wheat, Variety: BARI Gom 32
Design	**:**	RCB with 3 replications
Plot size	**:**	4m X 5m
Planting system/spacing	**:**	Factor A= Sown at three different times a) 20 November b) 20 December Factor B= T_1= Success 2.5 SC (Naturalyte Biological Spinosad 2.5%) @ 1.3ml/L water T_2= Biotrine M 1.2EC (Natural microorganism extract Emamectin 1.2%) @1ml/L water T_3= Detergent powder (Surf excel) 2gm/ L water T_4= Untreated control
Fertilizer dose and methods of application	**:**	As per BWMRI recommendation
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	a) Hill No./ 1 Linear Meter b) Attacked Leaf No./ 1 Linear Meter c) No. of aphid/ 1 Linear Meter d) Grain Yield e) No. of grain/ Spike f) TGW
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	Yield loss due to aphid infestation in wheat will be determined
Location	**:**	BWMRI, Dinajpur
Status	**:**	2nd year
Estimated cost	**:**	Tk. 60,000/-
Source of fund	**:**	BWMRI/CIMMYT

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.2	**:**	Maize Insects
Experiment 4.2.2.1	**:**	**Monitoring and scouting of insect pests on maize and their natural enemies**
Objective(s)	**:**	To document the prevalence and intensity of FAW attacking maize
Rationale	**:**	Maize is the third most important cereal crop in Bangladesh. Now-a-days, it is a very crucial crop due to its use as feed in poultry, dairy and fishery farm. But the crop is attacked by a number of insect pests both in the field during cultivation. Among the field insect pests, cut worm,

		Fall Armyworm (FAW), Armyworm, aphids etc. are quite serious and may cause considerable yield loss of the crop. Recent reports indicate that FAW is a potential threat for maize cultivation in Bangladesh (FAO 2019). Documentation of damage severity of FAW along with its peak infestation periods would enable researchers to take necessary steps to manage the pest problems.
Materials and methods	**:**	Different maize growing areas of the country will be visited at different growth stages of the crop to collect data of FAW prevalence and intensity through in-situ and pheromone trap. In each location, thirty farmers will also be interviewed using an objective oriented questionnaire to collect information on farmers' perception regarding FAW on maize.
Crop/genotype	**:**	Existing maize crop in the field
Design	**:**	-
Plot size	**:**	-
Planting system/spacing	**:**	Existing maize crop in the field
Fertilizer dose and methods of application	**:**	Existing maize crop in the field
Irrigated/rainfed	**:**	Existing maize crop in the field
Data to be recorded	**:**	1. Percent infestation. 2. No. of FAW larvae/ plant. 3. No. of FAW adult/ trap
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021 and Kharif-I 2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	Damage severity of different insect pests on maize will be documented. Natural enemies if the insect pests will also be collected and identified.
Location	**:**	Dinajpur, Thakurgaon, Panchagorh, Rangpur, Jashore, Bogura
Status	**:**	2nd year
Estimated cost	**:**	Tk. 60,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.2	**:**	Maize Insects
Experiment 4.2.2.2	**:**	**Development of management package(s) to control FAW on maize**
Objective	**:**	To develop a eco-friendly and sustainable management package against FAW attacking maize
Rationale	**:**	Maize is the third most important cereal crop in Bangladesh. Recent reports indicate that maize is attacked by Fall Armyworm (FAW), is quite serious and may cause considerable yield loss of the crop in Bangladesh. Therefore, it is necessary to develop a management package to control FAW in Bangladesh climatic condition.
Materials and methods	**:**	T_1= SNPV (microbial bio-pesticide) @ 0.2g/ L water + Soil Recharge @ 2kg/acre T_2 = Tracer 45SC (Spinosad) + Soil Recharge @ 2kg/acre T_3 = Ash 50% + Sand 50% + Soil Recharge @ 2kg/acre T_4 = Tracer 45SC (Spinosad) T_5 = Untreated control.

Crop/genotype	**:**	Crop: Maize, Variety: Pioneer 3355
Design	**:**	RCB with 3 replications
Plot size	**:**	10 m X 10 m
Planting system/spacing	**:**	Row to Row = 60 cm; Plant to Plant 25 cm
Fertilizer dose and methods of application	**:**	As per BWMRI recommendation
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	1. Percent infested plants 2. Percent infested cob 3. Intensity of cob infestation 4. Yield
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	A management package of FAW on maize will develop
Location	**:**	BWMRI, Dinajpur
Status	**:**	2nd year
Estimated cost	**:**	Tk. 70,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1
Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.2	**:**	Maize Insects
Experiment 4.2.2.3	**:**	**Effect of seed treatment with Cyantraniliprole (Fortenza 60FS) to control Fall Armyworm, *S. frugiperda* (Lepidoptera: Noctuidae) on maize**
Objective	**:**	To evaluate the seed treatment effect with insecticide, fortenza for the control of *S. frugiperda* in initial infestations of maize crops
Rationale	**:**	Maize is the third most important cereal crop in Bangladesh. Recent reports indicate that maize is attacked by Fall Armyworm (FAW), is quite serious and may cause considerable yield loss of the crop in Bangladesh. In Bangladesh, there is no registered insecticide yet as seed treatment against Fall Armyworm, *S. frugiperda*. Therefore, the goal of this study was to evaluate the seed treatment effect with insecticide, fortenza for the control of *S. frugiperda* in initial infestations of maize crops under field conditions..
Materials and methods	**:**	2.5 ml Fortenza will be taken in a polybag and 4 ml clean water to be added. Fortenza with water to be stirred well subject to decrease concentration and increase volume. One kilogram cleaned maize seed to be taken in that polybag and to be agitated to creat Fortenza layer on seed coat. Treated seeds will be dried about half an hour in shade followed by sown in the experimental field. T_1 = Fortenza treated T_2= Untreated control
Crop/genotype	**:**	Crop: Maize, Variety: Pioneer 3355
Design	**:**	RCB with 3 replications
Plot size	**:**	10 m X 10 m

Planting system/spacing	**:**	Row to Row = 60 cm; Plant to Plant 25 cm
Fertilizer dose and methods of application	**:**	As per BWMRI recommendation
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	1. Percent infested plants 2. Percent infested cob 3. Intensity of cob infestation 4. Yield
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	A part of IPM (integrated pest management) package against FAW on maize will be developed
Location	**:**	BWMRI, Dinajpur
Status	**:**	2nd year
Estimated cost	**:**	Tk. 70,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1

Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.2	**:**	Maize Insects
Experiment 4.2.2.4	**:**	**Assessment of the seasonal abundance and infestation intensity of FAW *S. frugiperda* (Lepidoptera: Noctuidae) on maize**
Objective	**:**	To evaluate the FAW abundance and infestation intensity on maize growing in different times
Rationale	**:**	Maize is the second cereal crop in Bangladesh considering acreage and production in the recent past few years. Its value is increasing day by day cause of high demand in poultry, dairy, and fish farms. Many cultivating lands are shifting from other crops to maize crop due to its high value and demand in the market. Rather than feed industry, human are also consuming maize including popcorn, baby corn, sweet corn etc.
Materials and methods	**:**	Maize will be grown in each month and started from October 2020 and observe the FAW abundance and infestation intensity on maize. In each time one treatment to be free from FAW and one treatment will be as control to assess the yield loss considering maize growing time. Sowing: Mid of each month, from October 2020 to May 2021 T_1 = Free from FAW T_2= Untreated control
Crop/genotype	**:**	Crop: Maize, Variety: Pioneer 3355
Design	**:**	RCB with 3 replications
Plot size	**:**	8 m X 6.6 m
Planting system/spacing	**:**	Row to Row = 60 cm; Plant to Plant 25 cm
Fertilizer dose and methods of application	**:**	As per BWMRI recommendation
Irrigated/rainfed	**:**	Irrigated

Data to be recorded	**:**	1. Percent infested plants
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	A part of integrated pest management package of FAW on maize will be developed
Location	**:**	BWMRI, Dinajpur
Status	**:**	1st year
Estimated cost	**:**	Tk. 100,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1
Programme	**:**	Wheat and Maize Improvement
Project 4	**:**	Pest Management
Sub-Project 4.2	**:**	Insect Management
Sub-Sub-Project 4.2.2	**:**	Maize Insects
Experiment 4.2.2.5	**:**	**Agro-ecological approaches of FAW *S. frugiperda* (Lepidoptera: Noctuidae) management on maize**
Objective	**:**	To develop culturally appropriate low-cost FAW control strategy
Rationale	**:**	The fall armyworm, *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae), is the most important noctuid pest in the Americas and has recently become an invasive pest in Asia after Africa that may affect maize production in Bangladesh. The term 'armyworm' can refer to several species, often describing larvae gather in huge masses ('armies'), which can destroys large tracks of crops. The bibliographic records and surveys resulted in a total of 353 host plants record belonging to 76 plant families, principally Poaceae (106), Asteraceae (31) and Fabaceae (31) in Brazil (Montezano et al., 2018). Nevertheless, mostly preferred host plants are maize, rice, sorghum, sugarcane, cotton and vegetable crops. In fact, FAW is native to Americas and alien invasive in Africa from 2016. In 2018, FAW was reported from the Indian subcontinent (IITA, 2018; ICAR-NBAIR, 2018) and has been recorded in Bangladesh, Cambodia, China, India, Indonesia, Lao DPR, Myanmar, Philippines, Sri Lanka, Thailand and Viet Nam. Therefore, it is necessary to develop a low-cost culturally appropriate management option against FAW.
Materials and methods	**:**	**Treatments** T_1 = Monoculture maize x Conventional tillage (Control) T_2 = Maize + Cowpea intercrop x Conventional tillage T_3 = Monoculture maize x Minimum tillage + mulching T_4 = Maize + Cowpea intercrop x Minimum tillage + mulching
Crop/genotype	**:**	Crop: Maize, Variety: Pioneer 3355
Design	**:**	RCB with 4 replications for on-station and 8 replications for on-farm trials
Plot size	**:**	12.6 m X 12.6 m
Planting system/spacing	**:**	Row to Row = 90 cm; Plant to Plant 25 cm
Fertilizer dose and methods of application	**:**	As per BWMRI recommendation
Irrigated/rainfed	**:**	Irrigated

Data to be recorded	**:**	1. No. of moth captured/ pheromone trap 2. Germination success 3. FAW abundance 4. FAW foliar damage 5. Abundance of predators and Parasitoids 6. Plant density, plant height, no. of cobs/ plant 7. Cob length, Cob damage 8. Intercrop yield 9. Climatic data
Investigator(s)	**:**	M.M.R. Shah, MI Hossain, R Islam, CIMMYT representatives
Season	**:**	Rabi, 2020-2021
Date of Initiation	**:**	November, 2020
Date of completion	**:**	May, 2021
Expt. output/benefit	**:**	Low-cost culturally appropriate management option against FAW will be developed
Location	**:**	Dinajpur, Rajshahi, Jashore
Status	**:**	1st year
Estimated cost	**:**	Tk. 100,000/-
Source of fund	**:**	CIMMYT
Priority	**:**	1

PROJECT 5: AGRICULTURAL ENGINEERING

1.	**Program**	**:**	Wheat and maize Improvement
2.	**Project 5**	**:**	Agricultural Engineering
3.	**Expt. 5.1**	**:**	**Battery operated low cost maize planter cum weeder**
4.	**Objective(s)**	**:**	i) To develop battery operated maize planter cum weeder ii) to test and evaluate the performance of battery operated weeder cum planter on station and in farmers' field iii) to compare the economic performance with conventional method
5.	**Rationale**	**:**	Weeds are plant that competes with crops for water, nutrients and light. Crop production can be reduced drastically due to excessive weed. Depending upon the weed density, 20-30% yield loss is quite usual but if inadequate crop management occurs, yield loss can climb up to 80%. The conventional method of weeding is highly labor intensive, costly and drudgerious. Chemical use of weeding is costly and very hazardous for environment. The battery operated weeder is to reduce drudgery and cost which ensures safe and easy solution to this problem. Mechanical weeding keeps the soil surface loose for ensuring soil aeration and water intake capacity. The weeder can be operated for both the wide row crops and vegetable crops. The design principle of the weeder offers an additional opportunity for it to be operated as a planter as well. The tines can till the soil and the battery operated weeder can also be used as maize planter. This provides an optional use of a single machinery to perform two operations at a time. It will reduce the negative impact of chemical weeding. Two simultaneous operation through a single machine will help the farmer accept mechanical method over the chemical and conventional one. . This will economically help the farmer to reduce production cost by minimizing intercultural operational expenses. Considering these facts the program has been taken.
6.	**Materials and Methods**	**:**	A DC motor operated dry land weeder cum planter will be designed and fabricated. The machine will provide a 48 volt 750 watt motor operated by 48 volt rechargeable dry cell battery. Power will be transmitted through chain and sprocket. Row to row distance will be adjustible. Different types of tines will be attached for it to be operated for wide row crop, vegetable crop as well as for tilling purposes. The machine can also be used as maize planter providing optimal plant to plant distance.
7.	**Crops**	**:**	Wheat, mungbean, maize, lentil, rice etc.
8.	**Data to be recorded**		Weeding index, field capacity, Seed rate, depth of seeding, plant population, area coverage per unit time, yield, and cost data to be recorded.
9.	**Investigators**	**:**	M S B Ekram, M I Hossain,
10.	**Season**	**:**	2020-21
11.	**Date of Initiation**	**:**	November 2020
12.	**Expected Output/Benefit**	**:**	Reduced production cost, minimizing negative impact of chemical weeding, timely weeding and planting, increasing farmers' livelihood
13.	**Locations**	**:**	BWMRI, Dinajpur
14.	**Status**	**:**	Ongoing 2nd year
15.	**Estimated Cost**	**:**	Tk. 1,00,000.00
16.	**Source of Fund**	**:**	BWMRI
17.	**Priority**	**:**	1st

1.	**Programme**	**:**	Wheat and maize Improvement
2.	**Project**	**:**	Agricultural Engineering
3.	**Expt. 5.2**	**:**	**Improvement of 2-wheel tractor operated strip till planter for upland crops**
4.	**Objective(s)**	**:**	i) to introduce inclined plate seed meter for improving the performance of strip till planter for wheat , maize and pulses cultivation with utilization of residual soil moisture ii) to compare the yield and cost performance of the planter over conventional method
5.	**Rationale**	**:**	Zero tillage is defined as the operation of planting crops in previously unprepared soil by opening a narrow slot or band only of sufficient width and depth to obtain proper seed coverage. Delay planting is one of the major causes of potential yield losses. Generally farmers take 8-11 days turnaround time between the two crops which allow more tillage and more cost. Power tiller operated zero till drill has been developed in WRC, BARI and performances was tested in research farm. It is now required on farm validation in the farmer's field for evaluating the performances of crop establishment in terms of energy saving, eliminate delay planting and moisture conservation.
6.	**Materials and Methods**	**:**	The working principle of the zero till planter is tilling operation, seeding in line, fertilizing during the seeding operation and seed covering simultaneously at a time in a single operation. All agronomic adjustments such as seed rate control, depth of seeding, line to line distance adjustment, multiple crops seeding are incorporated in the developed tractor driven zero till planter. The zero till planter consists of different functional components, seed and fertilizer box, mainframe, seed and fertilizer metering devices, tilling unit, tine, furrow opener, seed delivery tube, seed covering roller, power transmission chain and sprocket etc.
7.	**Crops**	**:**	Wheat, maize and pulses
8.	**Data to be recorded**	**:**	Seed rate, depth of seeding, plant population, yield and cost data to be recorded.
9.	**Investigators**	**:**	M S B Ekram, M I Hossain
10.	**Season**	**:**	2020-21
11.	**Date of Initiation**	**:**	November, 2020
12.	**Expected output**	**:**	Crops can be established timely with residual soil moisture utilization. Delay planting to be overcome. Energy consumption and cultivation cost will be less.
13.	**Locations**	**:**	Gazipur and BWMRI Dinajpur
14.	**Status**	**:**	Ongoing (2rd year)
15.	**Estimated Cost**	**:**	Tk. 80,000.00
16.	**Source of Fund**	**:**	BWMRI
17.	**Priority**	**:**	1st

1. Programme	**:**	Wheat and maize Improvement
2. Project	**:**	Agricultural Engineering
3. Exp. 5.3	**:**	**Development of tractor (4WT) operated multi crop seeder**
4. Objective(s)	**:**	• To fabricate a 4 wheel Tractor operated multi-row seeder for up land crops • To test the seeder performances both on station and in the farmers' field • To compare the cost of seeding with traditional broadcasting method
5. Rationale	**:**	Around 56000 four wheel tractors are already being used in Bangladesh. To get maximum crop production and yield, seeding operation needs to be completed within the recommended period avoiding slackness, time consuming, and costly operation and decreasing turnaround time. These 4 wheel tractors can be used for seeding purpose in addition to its transportation and soil tilling works. Thus, four wheel tractor operated seeding technology development is essential to ensure multidimensional use of four wheel tractors and to give more pace in seeding operation in parallel to the two wheel tractor operated seeding machinery.
6. Procedure/ Methods	**:**	A 4 wheel tractor operated seeder has been fabricated in the Agricultural Engineering Divisional workshop, WRC, Nashipur, Dinajpur during 2017-18. Locally available construction materials were used for fabrication. It was direct seeding type. The spacing between the lines were adjustable. The depth of seeding can be controlled. The performance of the seeder will be further evaluated and check for improvement.
7. Crop/variety	**:**	Wheat, maize, pulses
8. Planting system/spacing	**:**	Line sowing, 20 cm
9. Data to be recorded	**:**	Seed rate, depth of seeding, plant population, area coverage per unit time, yield and cost.
10. Investigators	**:**	M S B Ekram, M I Hossain
11. Season	**:**	2020-21
12. Date of Initiation	**:**	November 2020
13. Exp. Output/Benefit	**:**	Reduced cost and time for seeding in wheat, Interest development in line spacing and intercultural operation.
14. Locations	**:**	BWMRI, Dinajpur
15..Status	**:**	Ongoing (2rd year)
16. Estimated Cost	**:**	Tk. 100,000.00
17. Source of Fund	**:**	BWMRI
18. Priority	**:**	1st

PROJECT 6: TECHNOLOGY VALIDATION AND TRANSFER

Wheat is the second important cereal crop in Bangladesh. Its consumption is increasing @ 10% per year. But production is much below than the total requirement. The major causes for low production are low yield due to inadequate and slow technology adoption. The average wheat yield in research station is > 4.0 t/ha but the ever highest national average yield was 3.64 t ha^{-1} in 2019-20 as per DAE. Still there is a yield gap of about 1.0 ton/ha which is due to knowledge gap of the farmers about modern varieties and recommended technologies. In this situation, technology transfer activities are very important to increase wheat yield by improving farmers' knowledge. To improve farmers' knowledge, conducting demonstration, training, field day, workshop, seminar and publicity in mass media is very important.

A. NATINAL PROGRAMME

SUB-PROJECT 6.1: DEMONSTRATION

Demonstration is a very effective tool for disseminating varieties and technologies. Therefore, new varieties, as well as, other new technologies developed by BWMRI (Wheat Research Centre, BARI) need to be demonstrated in farmers' fields for their quick dissemination by replacing old varieties and technologies. Demonstration also helps identify location specific varieties and their expansion in different environments. It also helps BADC for planning future production, preservation and distribution of seeds. Demonstrations are conducted by the farmers in cooperation with DAE and scientists of BWMRI.

Programme	**:**	Wheat and Maize Improvement
Project 6	**:**	Technology Transfer
Sub-Project 6.1	**:**	Demonstration
Plan/Expt. 6.1.1	**:**	**Variety demonstration**
Objective (s)	**:**	evaluating new varieties by the farmers comparing with widely grown one preserving and disseminate seeds of farmers'-preferred varieties through farmers to farmers and increasing varietal diversity
Rationale	**:**	Demonstration is an important and efficient way of dissemination of new varieties. It also helps make available the seeds of new varieties and their rapid dissemination to other farmers.
Procedure/Methods	**:**	Five new wheat varieties: BARI Gom 28, BARI Gom 30, BARI Gom 32, BARI Gom 33 and WMRI Gom 1 are to be demonstrated (as per seed availability). Plot size of the demonstration will be 400 m^{-2} (10 decimal) per variety. One variety should be given to one farmer. Demonstration kits of seeds, fertilizers and signboard will be supplied to the farmers through corresponding SAAO/SA/SSA immediately after training by November 15, 2020. Number of demonstration will be 2140; 1950 through DAE and 160 through OFRD, BARI and 180 through CIMMYT, Caritas & RDRS. Data will be recorded on seeding date, no. of irrigations, yield in kg per 20 m^{-2} and per hectare for each variety, amount of seeds preserved, number of farmers visited and reactions of the farmers, supervising staff and officials to varieties.
Investigators	**:**	M Bodruzzaman, MM Bazzaz, MA Alam, MA Hakim, G Faruq, MM Rahman, MM Hossain, MI Hossain, AA Khan, MR Islam, MI hossain in collaboration with OFRD, DAE & NGOs.
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	November 2020
Exp. Output/Benefit	**:**	Farmers will know the performance of new varieties. They could preserve and sell seeds of new superior variety and earn more money.

Location	**Through DAE (Wheat)**			
	Sl	**Name of district**	**Varieties will be used (as per seed availability)**	**#**
Dinajpur&Rangpur	01	Dinajpur	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50

Region	02	Thakurgaon	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	100
	03	Panchagarh	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	75
	04	Rangpur	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	25
	05	Nilphamari	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	25
	06	Kurigram	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50
	07	Gaibandha	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	25
	08	Lalmonirhat	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50
Sub-total :				400
	09	Joypurhat	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	30
	10	Bogura	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	30
	11	Rajshahi	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	25
Bogura &Rajshahi	12	Naogaon	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50
Region	13	Natore	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50
	14	Nawabgonj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	100
	15	Pabna	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	100
	16	Sirajgonj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	40
Sub-total :				425
	17	Kushtia	BARI Gom 33	40
	18	Chuadanga	BARI Gom 33	20
	19	Meherpur	BARI Gom 33	40
	20	Jashore	BARI Gom 33	20
Jashore& Khulna	21	Jhenaidah	BARI Gom 33	30
Region	22	Magura	BARI Gom 33	30
	23	Narail	BARI Gom 33	25
	24	Satkhira	BARI Gom 33	25
	25	Khulna	BARI Gom 33	25
Sub-total :				255
	26	Faridpur	BARI Gom 33	30
	27	Rajbari	BARI Gom 33	50
	28	Gopalgonj	BARI Gom 33	30
Faridpur &Barishal	29	Madaripur	BARI Gom 33	25
Region	30	Shariatpur	BARI Gom 33	25
	31	Barishal	BARI Gom 33	25
	32	Bhola	BARI Gom 33	25
	33	Patuakhali	BARI Gom 33	25
Sub-total :				235
	34	Mymensingh	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	20
	35	Netrokona	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	15
Mymensingh Region	36	Jamalpur	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	30
	37	Sherpur	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	15
Sub-total :				80
	38	Tangail	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	50
	39	Sylhet	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	70
	40	Manikgonj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	15
Other Regions	41	Kishorganj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	20
	42	Cumilla	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	15
	43	Brahmanbaria	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	10
	44	Moulovibazar	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	30
	45	Habigonj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	30
	46	Sunamgonj	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	20
	47	Cox’s Bazar	BARI Gom 28, 30, 32, 33 & WMRI Gom 1	15
Sub-total :				275
DAE total :				**1285**
Others				

	48	OFRD, Mymensingh	BARI Gom 28, 30, 32 & 33	10
	49	OFRD, Sherpur	BARI Gom 28, 30, 32 & 33	10
	50	OFRD, Faridpur	BARI Gom 33	20
	51	OFRD, Patuakhali	BARI Gom 33	25
	52	OFRD, Tangail	BARI Gom 28, 30, 32 & 33	20
	54	OFRD, Gaibandha	BARI Gom 28, 30, 32 & 33	50
	55	OFRD, Rajshahi	BARI Gom 28, 30, 32 & 33	25
	56	CARITAS	BARI Gom 28, 30, 32 & 33	110
	57	CIMMYT	BARI Gom 28, 30, 32 & 33	50
	58	RDRS, Rangpur	BARI Gom 28, 30, 32 & 33	20
			Sub-total:	340
Maize demonstrations through DAE				
	59	Dinajpur	BHM 16	10
	60	Thakurgaon	BHM 16	10
	61	Panchagarh	BHM 16	10
	62	Rangpur	BHM 16	10
	63	Lalmonirhat	BHM 16	10
	64	Nilphamari	BHM 16	10
	65	Kurigram	BHM 16	10
	66	Gaibandha	BHM 16	10
	67	Banderban	BARI Sweet Corn 1 & BARI Pop Corn 1	25
	68	Khagrachari	BARI Sweet Corn 1 & BARI Pop Corn 1	25
			Sub-total:	130
Demontrations of wheat and maize with lime/Dolochun through DAE				
	69	Dinajpur	WMRI Gom 1 & BHM 16	30
	70	Thakurgaon	WMRI Gom 1 & BHM 16	30
	71	Panchagarh	WMRI Gom 1 & BHM 16	30
	72	Nilphamari	WMRI Gom 1 & BHM 16	30
	73	Lalmonirhat	WMRI Gom 1 & BHM 16	30
			Sub-total:	150
			Grand total :	**2140**

Status	**:**	On-going
Estimated Cost	**:**	Tk. 18,00,000/- (Tk.1500/- per demonstration for kit preparation)
Source of Fund	**:**	BWMRI
Priority	**:**	1

SUB-PROJECT 6.2: TRAINING, WORKSHOP AND FIELD DAYS

A. NATIONAL PROGRAMME

Programme	**:**	Wheat and Maize Improvement
Project 6	**:**	Technology Transfer
Sub-Project 6.2	**:**	Training, Workshop and Field days
Plan/Expt. 6.2.1	**:**	**Training to demonstration farmers and related personnel**
Objective(s)	**:**	The objective of the training is to teach variety demonstration farmers and related personnel (five SAAO for 25 demonstrations and one DAE Officer per batch as observer) about the systems of conducting demonstrations, data recording and sending, and wheat production and seed preservation technologies.
Rationale	**:**	Farmers' need to know the systems of conducting demonstrations and collecting data. In addition, farmers are less acquainted with modern production technologies of wheat. This training will help them in

conducting demonstrations properly and to improve knowledge on wheat production and seed preservation.

Procedure/Methods : Related farmers and other persons will be invited to a comfortable place and training will be given to them through visual aids, posters, lectures, etc. and a hand out about the demonstration will be supplied.

Investigators : Scientists of BWMRI

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Demonstration set-up will be perfect and farmers' knowledge on wheat and triticale production will improve

Locations :

Conducted by	Regions	No. Batches
BWMRI, Dinajpur	Rangpur & Dinajpur, Faridp., Barishal	33
RS, BWMRI, Rajshahi	Rajshahi & Bogura	19
RS, BWMRI, Jamalpur	Mymensingh	04
RS, BWMRI, Jashore	Jashore & Khulna	11
RS, BWMRI, Joydebpur	Dhaka & Sylhet	15

Status : On-going

Estimated Cost Tk. 16,40,000/- (Avg. Tk. 20,000/- per batch)

Source of Fund : BWMRI

Priority : 1

Programme : Wheat and Maize Improvement

Project 6 : Technology Transfer

Sub-Project 6.2 : Training, Workshop and Field days

Plan/Expt. 6.2.2 : **Training of trainers (TOT) on wheat production and seed preservation**

Objective(s) : to increase the knowledge and skill on wheat production and seed preservation techniques of the progressive farmers

Rationale : Farmers are less acquainted with modern production technologies of wheat. This training will help them to improve knowledge on wheat production and seed preservation.

Procedure/Methods : In each training batch 30 persons (25 large/medium farmers and 5 SAAO) will be invited during wheat growing season. Training will be given through theory and practical classes. Lectures will be presented through audio-visual aids and practical classes will be held in the wheat field. Hand-out of all classes will be supplied to the trainees.

Investigators : Scientists of BWMRI

Season : Rabi 2020-21

Date of Initiation : November 2020

Exp. Output/Benefit : Improve and update knowledge on wheat, its production and seed preservation techniques; which will help increase wheat yield and production in the country

Locations :

Location	No of participants (batch)
BWMRI, Dinajpur	150 (6 batches)
RS, BWMRI, Rajshahi	75 (3 batches)
RS, BWMRI, Jamalpur	50 (2 batches)
RS, BWMRI, Jashore	50 (2 batches)
RS, BWMRI, Joydebpur	50 (2 batches)
Total	375 (15 batches)

Status : On-going

Estimated Cost : Tk.3,75,000/-(Tk 25,000/- per batch)

Source of Fund : BWMRI

Priority : 1

Programme : Wheat and Maize Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field days
Plan/Expt. 6.2.3 : **Training of trainers (TOT) for DAE, BADC and NGO personnel on wheat production and seed preservation**

Objective(s) :
i. update the knowledge and skill on wheat production and seed preservation
ii. acquaint them with the new varieties and their distinguishing characteristics
iii. get the feedback about the causes of wheat area reduction and their provable solutions.

Rationale : BARI, DAE, BADC and NGO personnel are involved in wheat production and seed dissemination systems. Improving knowledge of these personnel about wheat, its production and seed preservation, will greatly help increase wheat yield and production in the country. They could also help disseminating new varieties and technologies.

Procedure/Methods : In each training batch 30 persons will be invited during wheat growing season. Training will be given through theory and practical classes. Lectures will be presented through audio-visual aids and practical classes will be held in the wheat field. Hand-out of all classes will be supplied to the trainees.

Investigators : Senior scientists of BWMRI
Season : Rabi 2020-21
Date of Initiation : November 2020
Exp. Output/Benefit : Improve and update knowledge on wheat, its production and seed preservation techniques; which will help increase wheat yield and production in the country

Locations :

Location	No of participants (batch)
BWMRI, Dinajpur	100 (4 batches)
RS, BWMRI, Rajshahi	75 (3 batches)
RS, BWMRI, Jamalpur	50 (2 batches)
RS, BWMRI, Jashore	50 (2 batches)
RS, BWMRI, Joydebpur	100 (4 batches)
Total	375 (15 batches)

Status : On-going
Estimated Cost : Tk. 6,00,000/-(Tk. 40,000/- per batch)
Source of Fund : BWMRI
Priority : 1

Programme : Wheat and Maize Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field days
Plan/Expt. 6.2.4 : **Five days training for young scientists on research planning, execution, data recording, analysis and reporting**

Objective(s) :
i. Introduce with the objectives, activities and future strategies of wheat research in Bangladesh
ii. Improve the knowledge of wheat research systems, methodologies, data recording, analysis and reporting

Rationale : Though the young scientists are of agriculture background, they have not got adequate knowledge on wheat and wheat research systems. Furthermore, a good number of scientists also recently posted to WRC. Therefore, it is very important to train them on wheat and wheat research for conducting future research efficiently.

Procedure/Methods	**:**	Training of SSO/SO will be conducted through theory and practical classes. Theory classes will be conducted in the class room followed by practical classed in the wheat fields and laboratories. Handout will be supplied for each lecture. Pre and post evaluation test will be taken to assess the improvement due to training.
Investigators	**:**	Senior scientists of BWMRI and BARI
Season	**:**	Rabi 2020-21
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Knowledge of wheat and wheat research system will increase that will ultimately help the young scientists to run their future research activities efficiently.
Location	**:**	BWMRI, Dinajpur
Status	**:**	New
Estimated Cost	:	Tk. 1,50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

Programme	**:**	Wheat and Maize Improvement
Project 6	**:**	Technology Transfer
Sub-Project 6.2	**:**	Training, Workshop and Field days
Plan/Expt. 6.2.5	**:**	**Two days training for SSA/SA/LA**
Objective(s)	**:**	i. to introduce with the objectives and different activities of wheat research in Bangladesh ii. to make familiar with different types of experimental design, laboratory protocols and data collection
Rationale	**:**	Each year, a considerable number of field and laboratory staffs join/transfer to different wheat research stations. Furthermore, some new experiments are also taken by the scientists every year. Recently, some molecular research were also included in wheat research programme. Therefore, scientific staffs of different stations of WRC need to be trained regularly to help the scientist in completing their research programme smoothly.
Procedure/Methods	**:**	Training of field and laboratory staffs will be conducted through theory and practical classes. Theory classes will be conducted in the class room followed by practical classed in the wheat fields and laboratories. Handout will be supplied for each lecture. Pre and post evaluation test will be taken to assess the improvement due to training.
Investigators	**:**	Scientists of BWMRI
Season	**:**	Rabi 2020-20
Date of Initiation	**:**	December 2020
Exp. Output/Benefit	**:**	Knowledge of wheat and wheat research of the field and laboratory staffs will be increased which will ultimately help them to follow the instructions of the scientists and run the wheat research activities efficiently.
Location	**:**	BWMRI, Dinajpur
Status	**:**	New
Estimated Cost	:	Tk. 50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

Programme : Wheat and Maize Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field days
Plan/Expt. 6.2.6 : **Regional Workshop on challenges in wheat production**
Objective(s) : Sharing the knowledge and skills for enhancing wheat production in the countryupdating the knowledge new wheat technologies among the stakeholders.
get the feedback about the challenges in wheat production and action to be taken to face these challenges.
Rationale : BARI, DAE, BADC, SCA and NGO personnel are the main stakeholders of wheat production and seed dissemination systems. Improving knowledge of these personnel about wheat, its production and seed preservation, will greatly help increase wheat yield and production in the country. They could give fruitful feedback to enhance the wheat productivity in the country.
Procedure/Methods : In each workshop, 60 persons will be invited during wheat growing season. A key note paper will be presented about the present situation of wheat production in Bangladesh. A brief presentation will also be given to update the knowledge about new technologies of WRC. A open-house discussion will be conducted and suggested recommendations will be noted down.
Investigators : Scientists of different research organization, teachers of Agril. Universities and personnel from DAE, BADC, SCA and NGOs
Season : Rabi 202-21
Date of Initiation : November 2020
Exp. Output/Benefit : updatingthe knowledge ofnew wheat technologies and feedback from different stakeholders will help to enhance the wheat productivity and production in the country

Locations :

Location	No. of workshop	No. of participants
Dinajpur-Rangpur	02	120
Bogura	01	60
Pabna	01	60
Jashore	01	60
Nawabganj	01	60
Faridpur-Barishal	02	120
Hill Tracts	01	60
Sylhet	01	60
Total	10	600

Status : New
Estimated Cost : Tk. 7,00,000/- (Tk 70,000/- per workshop)
Source of Fund : BWMRI
Priority : 1

Programme : Wheat and Maize Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field days
Plan/Expt. 6.2.7 : **Pre-review, Internal Review and Programme Planning workshops**
Objective(s) : i. to review the reports of research progress 2020-21.
ii. to formulate the research programme for 2021-22.
Investigators : Scientists of WRC
Season : Kharif 2021
Date of Initiation : May 2020

Locations :

Title	Location	Participants #
Pre-review Workshop	BWMRI, Dinajpur	30
Internal Review and Programme Planning workshops	BWMRI, Dinajpur	80
Total		110

Status : On-going
Estimated Cost : Tk. 3,00,000/-
Source of Fund : BWMRI
Priority : 1

Programme : Wheat and Maize Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field day
Plan/Expt. 6.2.8 : **Field days and monitoring of on-farm and on-station research activities in different agricultural regions**
Objective(s) : .showing and explain the performance of the new varieties and
.showing the impact of recommended technologies use in wheat yield
.monitoring of on-station research activities
Rationale : Field days at demonstration farmers' fields are very important to practically show the performance of the varieties comparing with the check one. It is a process of learning by seeing. This process of learning is more efficient than learning by hearing or reading.
Procedure/Methods : More than 100 farmers, DAE, research and NGO personnel will be invited in each demonstration fields and the advantages and disadvantages of the new varieties comparing with the widely grown check variety of the region will be shown.
Investigators : BWMRI and OFRD scientists of BARI and DAE personnel
Season : Rabi 2019-20
Date of Initiation : Rabi 2019
Exp. Output/Benefit : The advantages and disadvantages of the varieties used in demonstration will clearly be known to the farmers. As a result the farmers' will be convinced to accept the good one.

Locations :

Location (Agricultural region)	No. of field days
Rangpur and Dinajpur Region	30
Rajshahi and Bogura Region	15
Jashore, Faridpur and Barisal Region	10
Mymensingh Region	05
Dhaka, Kumilla & Sylhet Region	15
	Total : 75

Status : On-going
Estimated Cost : Tk.15,00,000/- (Tk.20,000/- per field day)
Source of Fund : BWMRI
Priority : 1

C. BUDGET FOR RESEARCH PROGRAMME OF BWMRI 2020-21

Sl No.	Project	Number of Experiment			Budget ('000 Taka)		
		National	Special	Total	National	Regional	Total
1	Wheat Variety Development	53	6	59	19645	225	21895
2	Maize Variety Development	29	4	33	2000	900	2900
2	Crop and soil Management	12	-	12	1660	-	1660
3	Pest Management	16 (Path.)	7 (Entom.)	23	3835	-	3835
4	Agricultural Engineering	03	-	03	208	-	208
5	Technology transfer	09	-	09	7115	-	7115
Total		**122**	**17**	**139**	**34463**	**1125**	**35588**