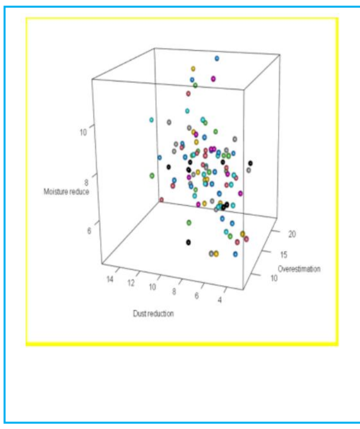
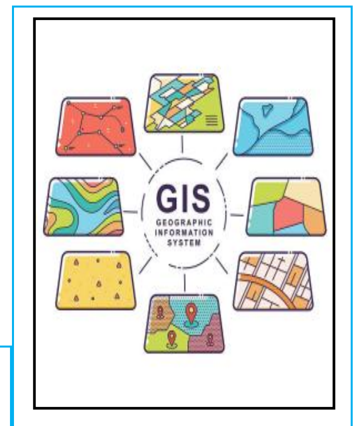
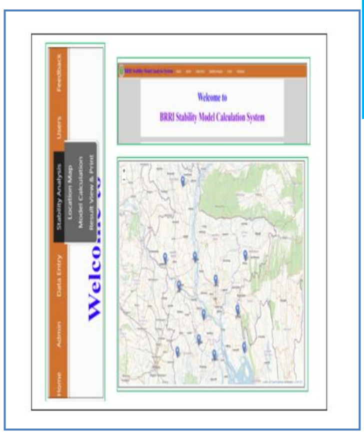
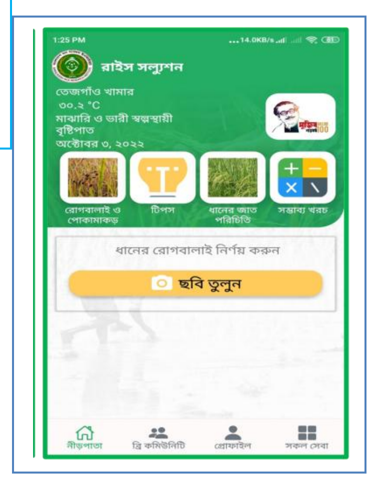
ANNUAL RESEARCH REVIEW WORKSHOP

2023-24









XIV

AGRICULTURAL STATISTICS DIVISION

BANGLADESH RICE RESEARCH INSTITUTE

GAZIPUR 1701

CONTENTS

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Summary

T. Aman varieties, BRRI dhan49, BRRI dhan87 and BRRI dhan93 were found stable. None of the varieties were found to be unstable during T. Aman season. Among the aromatic rice BRRI dhan5, BRRI dhan34, BRRI dhan37 and BRRI dhan38 were found as below average stable in T. Aman season. Boro varieties,BRRI dhan89, BRRI dhan101, and BRRI hybrid dhan8 were found stable. None of the varieties were found to be unstable during Boro season. On the other hand, only aromatic rice varieties BRRI dhan50 appeared to below average stable.

Aus and Aman rice yields have shown more sporadic improvements than Boro rice, which faced more significant yield losses in specific years. Total rice yield trends indicate relative stability in recent years, encouraging long-term food security planning in the country. SPEIs of different times are the most influential factor affecting rice yields in Bangladesh, emphasizing the importance of monsoon moisture for Aus, sensitivity to late-season SPEI for Aman, and dry season management for Boro. Additionally, relative humidity significantly impacts yields across all seasons, stressing the need for climate-adaptive strategies to manage drought risks and optimize humidity levels.

The highly significant genotype × environment interaction effects for grain yield confirmed that genotypes responded differently to the variation in environmental conditions for long, medium, and short-duration T.Aman varieties. Greater portion of the total variation was explained by the environmental main effect, indicating that the environments were diverse and a major part of the variation in grain yield was reflected by environmental changes. In the Aman season, BR11 and BRRI dhan30 recorded the highest average grain yielder and ideal genotypes among long-duration varieties. BRRI dhan103, BRRI dhan94, BRRI dhan51, and BRRI dhan49 were the most stable genotypes with above-average yield in medium duration, where BRRI dhan87, BRRI dhan72, BRRI Hybrid dhan6, BRRI Hybrid dhan4 and BRRI dhan95 were the most stable genotypes and above average yielder for short duration.

Database management and visualization system significantly enhanced BRRI's ability to manage, analyze and interpret demonstration data. Visualization tools were integrated into the database system to transform raw data into comprehensible visual formats. Which supports evidence-based decision-making and the way for improved rice production strategies in Bangladesh.

Rice area increased about one and half folds but the production increased about four folds during 1971-72 to 2022-23. Although the growth rate of rice area was 3.96 in year 1972-73 but in 2022-23 is -0.005. Similarly, growth rate of rice production was 1.30 in year 1972-73 but in 2022-23 is 0.03.

In Boro season, BRRI dhan101 and BRRI dhan104 are suitable mainly in north-western part of Bangladesh but BRRI dhan102 is also suitable in all over the western part of Bangladesh. In T.Aman season, BRRI dhan103 are suitable mainly in north-western part of Bangladesh

More or less throughout the year eastern side of Bangladesh is high rainfall and low temperature area and western side is low rainfall and high temperature area. Spatial distribution of minimum temperature and total rainfall are more or less same but maximum temperature is vice-versa to minimum temperature and total rainfall.

During Aman 2023 season about 5.91 Mha of rice were cultivatedin Bangladesh and highest Aman production district was Naogaon. In the year 2022 total Aman area was 5.82 Mha. Thus, total Aman area has been increased a little bit in the year 2023. In 2023-24 total Boro area was about 4.93 Mha in Bangladesh. Naogaon district produced the highest Boro production in 2023-24.

In all divisions of Bangladesh, average total precipitation (average by RCP 2.6, 4.5, 6.0, and 8.5 models) of August month in 2050 will be decreased in comparison to average total precipitation of 2010-2018 period, only exceptions are Khulna, Rajshahi, Mymensingh divisions.

Mustard-Fallow-T.Aman cropping pattern is suitable in north-west part of Bangladesh and total suitable area is 1.8Mha. Mustard-Boro-B.Aman cropping pattern cover total suitable area 1.32 Mha and these suitable area in central side of Bangladesh. Mustard-Jute-T.Aman is suitable in north-west and central northern sides of Bangladesh and total suitable area is 0.99 Mha..

Among the random-forest, support vector, linear-regression and ensemble model we found ensemble model is the best fitted model for yield prediction but still model is not good fitted model. So, the study should continue to improve the model.

For five years, Amtali Upazila's rice production areas have seen several notable changes that have revealed the dynamic nature of the area's agricultural practices and land use. Although the continuous rice farming stayed steady, there was a notable increase in the more recent rice cultivation zones, which were mostly homesteads, urban areas, non-rice crops, and fallow areas.

In the reporting year, two types of training were conducted under “Capacity Building through Training” programme. A total of 60 participants were trained through the training programmes. The participants of these training were scientists and SA, FM and AFM of BRRI.

Seven activities have been done in the reporting year 2023-24 under the project Computer programming, Software Development and Digitization. A new web application has been developed to calculate the stability index for BRRI stability model and a new unique platform for BRRI developed all the Management Information System (MIS). Also developed a dynamic web application for visualizing and analyzing the rice disease surveillance data. Four web applications have been updated and continuously run in the whole reporting year named (1) Salary Management System for BRRI HQ (2) Labour Management System for BRRI HQ (3) Quota Management System and (4) Tour Distance Calculation System from BRRI HQ.

ICT cell of this division has developed Sensor-based rice pest management through Artificial Intelligence (AI) technology named ‘Rice Solution’ mobile App and Rice profiling App. Also, developed ‘BRRI Rice doctor’ mobile and web apps both English and Bengoli version with the help of different divisions of BRRI. Developed dynamic view connectivity, Bangla search and inner banner system for BRKB web apps. Besides, modified the RKB mobile apps and disseminate of modern rice technology and its management information at the farmer door step through RKB Mobile Apps. We developed Vehicle Requisition Management System (VRMS) of BRRI. So that, the requester informed through SMS on basis of demanding vehicle for official or personal purpose as well as driver get confirmation SMS for their upcoming duty. Also, we developed “BRRI Alapon” Telephone Directory Mobile App. We established video conferencing system (VCS) at BRRI to communicate with MoA and others government organization. We organized five day-long, two day-long, day-long ‘Public Service Innovation’ training workshops in the reporting year.

Project 1: Statistical methodology in Rice Research

Experiment 1.1: Stability Analysis of BRRI varieties

(In collaboration with Plant Breeding Div., Plant Physiology Div., Agronomy Div., ARD and BRRI R/S's)

-Md. Ismail Hossain, Md. Abdul Qayum, Md. Abdullah Aziz, Md. Abdullah Al Mamun, Md. Sazzadur Rahman, Khandakar Md Iftekharuddaula, Md. Humyaun kabir and One Scientist from each Regional Station

Introduction

Stability models developed by Comstock and Robinson (1952), do not consider the response of environment on genotypic variation in identification of stability of the genotypes and thus, there is no information on how the genotypes will behave under rich, average or poor environment. On the other hand, Finlay and Wilkinson's (1963), also Eberhart and Russell (1966) used the concept of regression analysis in their stability models. The most serious and logical objection to the regression technique for stability analysis is that the site means or the environmental indices, which are employed as independent variables, are essentially not independent of the dependent variables, i.e., genotype means. Another serious limitation of the stability models those use regression technique is for the regression coefficients, use for measuring the stability of varieties which are unreliable due to poor to very poor fit of the regression model to the observed data in most of the cases. Thus, the models that use the regression technique to determine the varietal stability is not out of criticism. So, a new model was developed for stability analysis of genotypes in the year 2004-05 that avoids the jargons of regression analysis and uses a single index to identify the stability of a genotype across different environments and calibration and fine-tuning work on the model is doing since last year.

Objectives

1. To determine the stability index of BRRI released varieties
2. To maintain season, year and location-wise database on BRRI varieties.
3. To determine the interaction of BRRI varieties (genotypes) across all the environment

Materials and Method

Experiments are being conducted in T. Aman season and Boro with BRRI released rice varieties since 2001-24 at Gazipur and different regional stations. The collaborative regional stations in the T. Aman season are Rajshahi, Rangpur, Cumilla, Sonagazi, Barishal, Satkhira and Kushtia and in the Boro season Rajshahi, Rangpur, Cumilla, Habiganj, Barishal, Bhanga, Satkhira, Sonagazi and Kushtia. The numbers of varieties are 49 and 52 in T. Aman and Boro season respectively. The design was RCB with three replications and the effective plot size (harvest area) was 3.0-x-3.2 m^2 leaving the two-border row from each side. Recommended crop management practices were followed. Stability analysis of the experimental data was performed by using a newly developed model. The model deals with the performance of the genotypes across the geographical locations differing in land, soil and other biotic and abiotic factors over the years characterizing fluctuation of weather variable, floods, drought etc. Stability analyses of the experimental data were performed following the newly BRRI developed model, which is described below:

The stability model

The newly developed stability model takes into account the performance of the genotypes across the geographical locations differing in land, soil and other biotic and abiotic factors over the years characterizing fluctuation of weather variable, floods, drought, etc.

In the new model, the stability of a genotype is determined by three parameters. These are:

(1) Measure of yield fluctuation of i^{th} variety, $S_i = \frac{\sum_{j=1}^{s} S_{ij}}{s}$

S_{ij} is the coefficient of variation (CV) of the yield index of i^{th} variety in j^{th} location and is computed as,

$S_{ij} = \frac{V_{ij}}{\bar{z}_i} \times 100$, where

$V_{ij} = \sqrt{\frac{\sum_{k=1}^{t} \left(z_{ijk} - \bar{z}_{ij}\right)^2}{t}}$ = yield index of i^{th} variety in j^{th} location,

where, $\bar{z}_{ij} = \sum_{k=1}^{t} \frac{z_{ijk}}{t}$

$z_{ijk} = \frac{\bar{y}_{ijk}}{\bar{y}_{jk}}$ = Yield index of ith variety in jth location and kth year with respect to average yield of all varieties in jth location and kth year

$\bar{y}_{ijk} = \frac{\sum y_{ijkl}}{r}$ = Average yield of ith variety in jth location and kth year $\bar{y}_{jk} = \frac{\sum \bar{y}_{ijk}}{v}$ = Average yield of all varieties in jth location and kth year

y_{ijkl} = ith variety yield of lth replication in jth location and kth year.

v = no. of variety, s = no. of location, t = no. of years and r = no. of replication.

(2) Measure of performance of ith variety, $D_i = \frac{\sum_{j=1}^{s} d_{ij}}{s}$

(3) Measure of superiority of ith variety in jth location, $d_{ij} = \frac{(\bar{z}_{ij} - \bar{z}_j)}{\bar{z}_j} \times 100$; where, $\bar{z}_j = \frac{\sum_{i=1}^{v}\sum_{k=1}^{t} z_{ijk}}{tv}$.

A variety for which S_i is the minimum, $d_{ij} \geq 0$ for all j and D_i is a positive maximum, is defined as the most stable variety among the alternatives: stable across the locations and over the years.

In other words, a variety to be stable

- Should have minimum variability than other varieties
- Should yield consistently higher than other varieties across the locations and
- Should have higher yield than other varieties over locations and years

Combining the three quantities S_i, D_i and d_{ij}, the stability index of ith genotype is defined as:

$$G_i = \left(F_i^I + P_i^I + S_i^I\right)$$

where, F_i^I = Fluctuation index of ith variety = $\frac{Min(S_i)}{S_i}, i = 1, 2, 3, ...v$

P_i^I = Performance index of ith variety = $\frac{D_i}{Max(|D_i|)}$, i = 1, 2, 3,.......v

S_i^I = Superiority index of ith variety = $\frac{P_i}{t\,x\,s}, i = 1, 2, 3, ...v$

P_i = No of times the ith variety exceeded $\bar{z}_{ij}$ in all locations and year.

The value of G_i ranges from –1 to +3 i.e., $-1 \leq G_i \leq 3$. The higher the value of G_i more is the stability of the genotype across the environments. Stability of a variety is characterized as follows:

Value of G_i	**Nature of stability**
≤ 0	Unstable
$0 < \mathbf{G_i} \leq 1$	Below average stable
$1 < G_i \leq 2$	Average stable
$2 < G_i \leq 3$	Stable

Results and Discussion

Among T. Aman varieties, BRRI dhan49, BRRI dhan87 and BRRI dhan93 were found stable with stability index 2.00, 2.11 and 2.10 respectively. while BR3, BRRI dhan33, BRRI dhan39, BRRI dhan56, BRRI dhan57, BRRI dhan62, BRRI dhan70, BRRI dhan76, BRRI dhan90 and BRRI dhan91 appeared to be below average stable. BR4, BR10, BR11, BR22, BR23, BR 25, BRRI dhan30, BRRI dhan31, BRRI dhan32, BRRI dhan40, BRRI dhan41, BRRI dhan44, BRRI dhan46, BRRI dhan49, BRRI dhan51, BRRI dhan52, BRRI dhan53, BRRI dhan54, BRRI dhan66, BRRI dhan71, BRRI dhan72, BRRI dhan73, BRRI dhan75, BRRI dhan77, BRRI dhan78, BRRI dhan79, BRRI dhan80, BRRI dhan93, BRRI dhan94, BRRI dhan95, BRRI hybrid dhan4 and BRRI hybrid dhan6 were found having average stability among T. Aman varieties. Among the aromatic rice BRRI dhan5, BRRI dhan34, BRRI dhan37 and BRRI dhan38 were found as below average stable in T. Aman season (Table 1).

The maximum average yield (t/ha) of long duration varieties in the last 23 years was found. 4.41 (t/ha) and minimum 2.79 (t/ha). For medium duration varieties, maximum yield were found 4.48 (t/ha) and min. 3.66 (t/ha) and for short duration varieties maximum yield were found 5.12 (t/ha) and min. 3.37 (t/ha) during T.Aman (Graph 1, 2 and 3).

Among Boro varieties, BRRI dhan89, BRRI dhan101, and BRRI hybrid dhan8 were found as stable with stability index 2.11, 2.15 and 2.00 respectively. BR3, BR9, BR14, BR15, BRRI dhan29, BRRI dhan55, BRRI dhan58, BRRI dhan59, BRRI dhan61, BRRI dhan67, BRRI dhan68 BRRI dhan69, BRRI dhan74, BRRI dhan86, BRRI dhan88, BRRI dhan92, BRRI dhan96, BRRI dhan97, BRRI dhan99, Bangabandhu dhan100, BRRI dhan102, BRRI dhan105, BRRI hybrid dhan2, BRRI hybrid dhan3 and BRRI hybrid dhan5 varieties were found as average stable and rest of the 25 varieties appeared to be below average stable. Among the non-aromatic rice. On the other hand, only aromatic rice BRRI dhan50 were found as below average stable in Boro season (Table 2).
The maximum average yield (t/ha) of long duration varieties in the last 23 years was found. 4.41 (t/ha) and minimum 2.79 (t/ha). For medium duration varieties, maximum yield were found 4.48 (t/ha) and min. 3.66 (t/ha) and for short duration varieties maximum yield were found 5.12 (t/ha) and min. 3.37 (t/ha) during Boro (Graph 4, 5 and 6). .

From the yield data 2001-2023 of BRRI varieties the average maximum yield was observed 6.67 t/ha and average minimum yield was observed 1.39 t/ha in T. Aman varieties. The yield data 2001-02 to 2023-24 the average maximum yield was observed 8.89 t/ha and average minimum yield was observed 2.86 t/ha in Boro varieties (Table 3). The yield differences due to lodging, lack of management, disease and insect infestation, bird and rat damage etc.

Fig. 1: Average yield (t/ha) of long duration varieties in the last 23 years during T.Aman

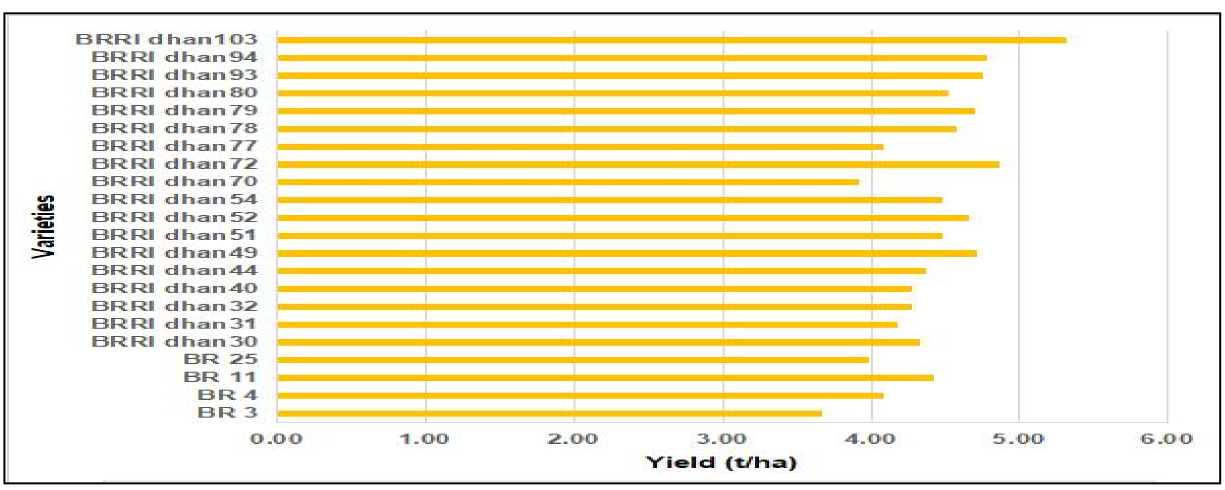


Fig. 2: Average yield (t/ha) of Medium duration varieties in the last 23 years during T.Aman

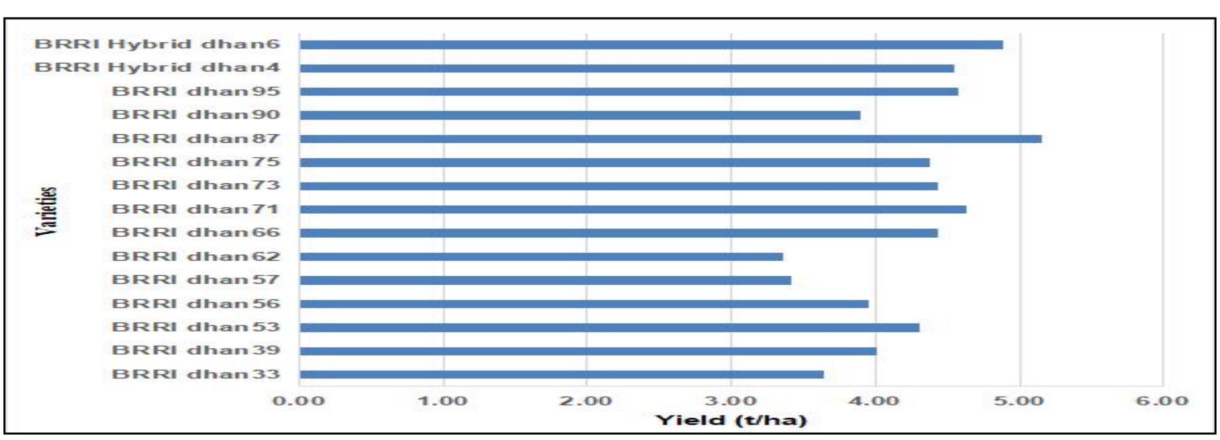


Fig. 3: Average yield (t/ha) of short duration varieties in the last 23 years during T.Aman

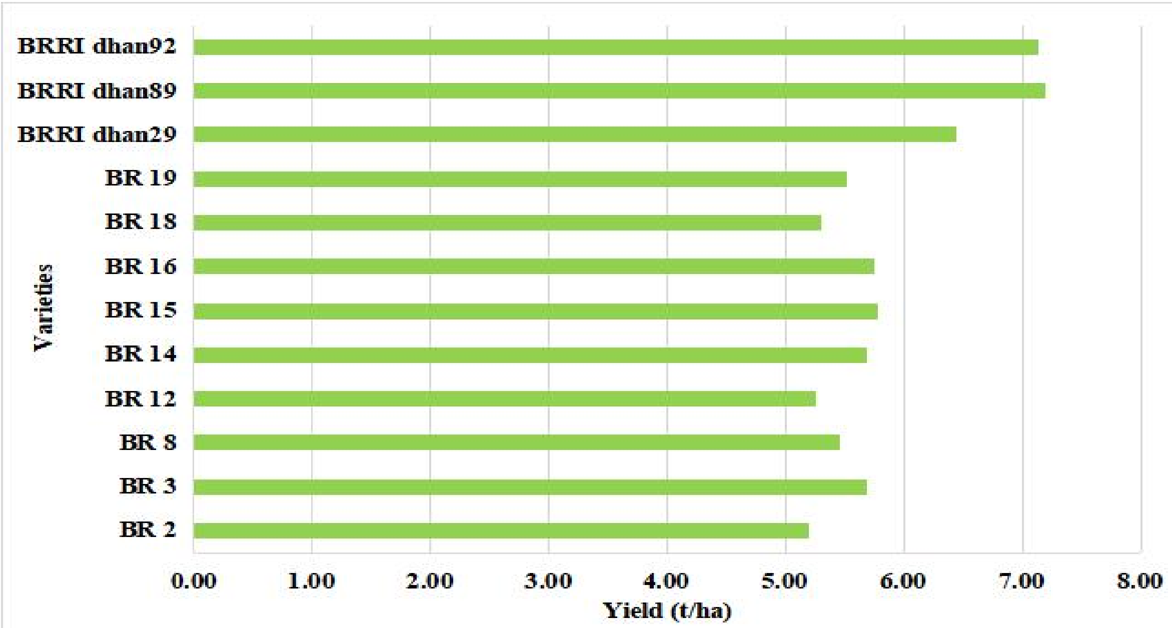


Fig. 4: Average yield (t/ha) of long duration varieties in the last 23 years during Boro

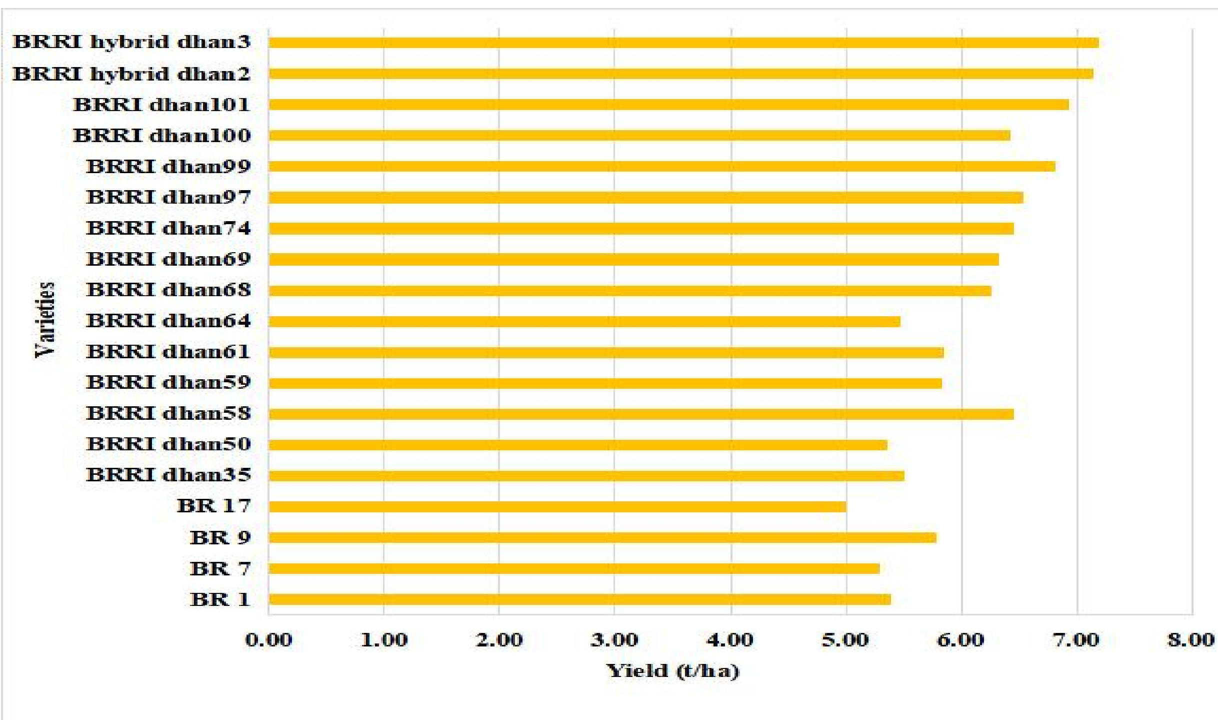


Fig. 5: Average yield (t/ha) of medium duration varieties in the last 23 years during Boro

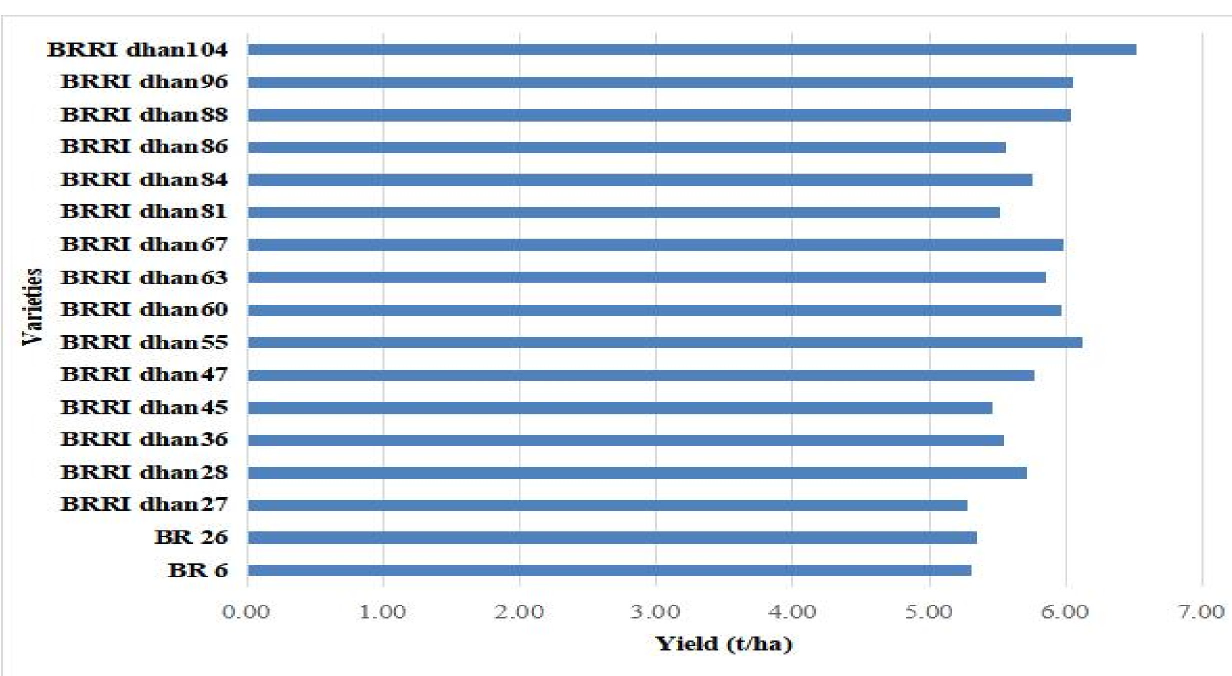


Fig. 6: Average yield (t/ha) of short duration varieties in the last 23 years during Boro

Table 1. Stability parameters of grain yield for T. Aman.

Variety	Stability parameter 2001-2022			Stability index	Stability rank	Nature of stability
	Si	Di	Pi	Gi	Ri	
Non-aromatic rice						
BR 3	17.95	-9.92	98	0.78	39	BAS
BR 4	13.36	-0.16	88	1.22	26	AS
BR 10	13.68	7.72	80	1.40	16	AS
BR 11	14.10	7.94	93	1.45	13	AS
BR 22	14.20	5.16	96	1.38	18	AS
BR 23	16.46	0.20	91	1.10	32	AS
BR 25	15.81	-1.60	91	1.08	33	AS
BRRI dhan30	12.77	6.35	95	1.50	11	AS
BRRI dhan31	13.74	1.83	98	1.30	21	AS
BRRI dhan32	16.39	5.82	102	1.35	19	AS
BRRI dhan33	20.62	-11.49	87	0.62	41	BAS
BRRI dhan39	17.34	-2.19	84	0.97	35	BAS
BRRI dhan40	14.38	5.17	97	1.39	17	AS
BRRI dhan41	16.92	2.28	94	1.17	29	AS
BRRI dhan44	14.27	6.55	64	1.33	20	AS
BRRI dhan46	15.81	-0.18	68	1.12	31	AS
BRRI dhan49	10.96	11.90	62	2.00	3	S
BRRI dhan51	16.23	5.37	52	1.25	25	AS
BRRI dhan52	11.36	9.00	56	1.67	7	AS
BRRI dhan53	13.98	1.61	49	1.26	24	AS
BRRI dhan54	18.17	5.27	48	1.20	28	AS
BRRI dhan56	16.57	-6.93	55	0.94	36	BAS
BRRI dhan57	20.09	-19.32	52	0.43	43	BAS
BRRI dhan62	26.73	-21.32	47	0.28	46	BAS
BRRI dhan66	13.16	3.34	42	1.40	15	AS
BRRI dhan70	17.42	-8.88	30	0.73	40	BAS
BRRI dhan71	12.85	8.24	34	1.51	10	AS
BRRI dhan72	11.36	13.81	33	1.76	5	AS
BRRI dhan73	15.38	3.47	39	1.30	22	AS
BRRI dhan75	16.18	1.61	34	1.14	30	AS
BRRI dhan76	17.41	-7.26	39	0.90	37	BAS
BRRI dhan77	13.80	-5.92	37	1.06	34	AS
BRRI dhan78	13.50	6.49	30	1.50	12	AS
BRRI dhan79	10.03	10.13	25	1.77	4	AS
BRRI dhan80	12.94	5.76	27	1.45	14	AS
BRRI dhan87	12.36	19.49	28	2.11	1	S
BRRI dhan90	15.20	-8.79	17	0.88	38	BAS
BRRI dhan91	18.85	-32.70	18	0.03	48	BAS
BRRI dhan93	10.66	12.28	19	2.10	2	S
BRRI dhan94	13.02	12.83	17	1.64	8	AS
BRRI dhan95	18.25	8.12	17	1.28	23	AS
BRRI dhan103	-	24.01	9	1.73	6	AS
BRRI Hybrid dhan4	17.55	4.97	40	1.20	27	AS
BRRI Hybrid dhan6	15.50	14.87	33	1.63	9	AS
Aromatic rice						
BR 5	19.70	-23.74	93	0.29	45	BAS
BRRI dhan34	20.52	-26.25	96	0.21	47	BAS
BRRI dhan37	18.35	-24.09	97	0.33	44	BAS
BRRI dhan38	16.87	-20.84	95	0.47	42	BAS

Note: AS=Average stable, BAS=Below average stable, Stable=S and Unstable=US

Table 2: Stability parameters of grain yield for Boro

Variety	Stability Parameter 2001-2023			Stability Index	Stability Rank	Nature of Stability
	Si	Di	Pi	Gi	Ri	
Non-Aromatic Rice						
BR1	11.49	-6.53	98	0.72	41	BAS
BR2	12.65	-10.21	106	0.58	48	BAS
BR3	10.07	-1.48	108	1.03	22	AS
BR6	13.23	-8.07	103	0.62	47	BAS
BR7	12.53	-8.32	104	0.5	46	BAS
BR8	12.92	-5.91	100	0.70	42	BAS
BR9	10.96	0.58	105	1.05	19	AS
BR12	11.24	-8.76	104	0.68	44	BAS
BR14	9.90	-1.46	107	1.04	21	AS
BR15	11.41	0.37	110	1.05	20	AS
BR16	12.29	-0.37	103	0.94	29	BAS
BR17	20.42	-12.99	93	0.23	52	BAS
BR18	10.97	-8.64	103	0.69	43	BAS
BR19	11.81	-4.811	99	0.78	38	BAS
BR26	10.64	-7.35	110	0.79	36	BAS
BRRI dhan27	13.17	-8.35	95	0.58	49	BAS
BRRI dhan28	12.40	-0.60	106	0.95	28	BAS
BRRI dhan29	10.03	11.46	106	1.52	9	AS
BRRI dhan35	11.60	-4.86	100	0.79	35	BAS
BRRI dhan36	11.62	-3.95	103	0.83	34	BAS
BRRI dhan45	13.41	-7.06	87	0.68	45	BAS
BRRI dhan47	10.24	-1.99	70	0.98	26	BAS
BRRI dhan55	10.25	1.20	63	1.16	18	AS
BRRI dhan58	10.21	7.00	63	1.38	10	AS
BRRI dhan59	12.31	-3.39	59	0.89	31	BAS
BRRI dhan60	12.10	-1.4	54	0.94	30	BAS
BRRI dhan61	10.04	-3.20	58	1.01	25	AS
BRRI dhan63	9.80	-4.71	41	0.87	33	BAS
BRRI dhan64	12.90	-10.30	43	0.51	51	BAS
BRRI dhan67	10.79	-2.63	52	1.03	23	AS
BRRI dhan68	9.22	2.36	47	1.25	14	AS
BRRI dhan69	9.79	3.17	42	1.19	16	AS
BRRI dhan74	11.02	5.81	44	1.25	15	AS
BRRI dhan81	12.26	-11.13	30	0.56	50	BAS
BRRI dhan84	10.85	-7.53	28	0.73	40	BAS
BRRI dhan86	9.28	-10.25	32	0.78	37	BAS
BRRI dhan88	9.85	-2.73	31	1.02	24	AS
BRRI dhan89	10.34	15.59	29	2.11	2	S
BRRI dhan92	9.99	12.57	28	1.63	7	AS
BRRI dhan96	9.54	-4.30	17	0.88	32	AS
BRRI dhan97	9.37	3.48	17	1.19	17	AS
BRRI dhan99	11.04	7.82	20	1.33	11	AS
BRRI dhan100	9.12	3.76	14	1.26	13	AS
BRRI dhan101	5.90	9.15	10	2.15	1	S
BRRI dhan102	9.22	10.32	10	1.53	8	AS
BRRI dhan104	#N/A	-0.56	10	0.98	27	BAS
BRRI dhan105	#N/A	7.39	10	1.28	12	AS
BRRI hybrid dhan2	10.08	17.13	48	1.72	6	AS
BRRI hybrid dhan3	10.61	17.56	54	1.77	4	AS
BRRI hybrid dhan5	10.98	18.81	39	1.74	5	AS
BRRI hybrid dhan8	#N/A	26.44	10	2.00	3	S
Aromatic Rice						
BRRI dhan50	9.55	-8.22	67	0.78	38	BAS

Note: S=Stable, AS=Average Stable, BAS=Below Average Stable

Table 3: Maximum and minimum yield of BRRI released rice variety (2001- 2024)

SL	T.Aman (2001 to 2023)			Boro (2001-02 to 2023-2024)		
	Varieties	Max.	Min.	Varieties	Max.	Min.
1	BR 3	6.49	0.94	BR 1	8.38	1.66
2	BR 4	6.54	0.96	BR 2	7.98	1.34
3	BR 5	6.17	0.63	BR 3	8.23	2.30
4	BR 10	7.37	1.03	BR 6	9.65	1.86
5	BR 11	8.73	0.65	BR 7	8.54	2.17
6	BR 22	6.38	1.17	BR 8	9.23	1.18
7	BR 23	6.64	0.95	BR 9	8.83	2.12
8	BR 25	6.86	1.27	BR 12	7.9	2.22
9	BRRI dhan30	6.90	1.18	BR 14	8.33	2.50
10	BRRI dhan31	7.00	1.20	BR 15	9.77	2.06
11	BRRI dhan32	7.31	1.61	BR 16	8.64	1.75
12	BRRI dhan33	6.72	0.94	BR 17	7.8	1.46
13	BRRI dhan34	5.91	0.68	BR 18	8.36	1.34
14	BRRI dhan37	6.18	0.66	BR 19	8.78	1.62
15	BRRI dhan38	6.42	0.67	BR 26	8.51	2.12
16	BRRI dhan39	6.77	0.85	BRRI dhan27	7.87	1.68
17	BRRI dhan40	6.79	1.15	BRRI dhan28	9.65	2.28
18	BRRI dhan41	6.98	0.84	BRRI dhan29	9.53	2.22
19	BRRI dhan44	6.75	1.49	BRRI dhan35	8.47	1.53
20	BRRI dhan46	6.84	1.45	BRRI dhan36	8.87	2.40
21	BRRI dhan49	7.60	2.15	BRRI dhan45	8.53	1.83
22	BRRI dhan51	7.25	1.00	BRRI dhan47	7.98	2.24
23	BRRI dhan52	8.07	2.13	BRRI dhan50	7.25	2.15
24	BRRI dhan53	6.63	1.76	BRRI dhan55	11.24	2.26
25	BRRI dhan54	7.00	1.66	BRRI dhan58	9.67	3.18
26	BRRI dhan56	6.46	1.23	BRRI dhan59	8.32	1.97
27	BRRI dhan57	5.59	1.00	BRRI dhan60	9.92	2.52
28	BRRI dhan62	5.54	0.76	BRRI dhan61	8.11	3.13
29	BRRI dhan66	6.69	1.41	BRRI dhan63	9.3	3.29
30	BRRI dhan70	6.30	1.72	BRRI dhan64	8.16	2.25
31	BRRI dhan71	7.07	1.40	BRRI dhan67	10.47	3.49
32	BRRI dhan72	7.41	1.85	BRRI dhan68	9.22	3.64
33	BRRI dhan73	6.93	1.36	BRRI dhan69	8.89	3.60
34	BRRI dhan75	6.61	1.27	BRRI dhan74	8.95	3.67
35	BRRI dhan76	6.22	0.97	BRRI dhan81	7.45	3.00
36	BRRI dhan77	6.39	1.52	BRRI dhan84	9.7	3.25
37	BRRI dhan78	6.36	1.98	BRRI dhan86	7.45	3.56
38	BRRI dhan79	6.34	2.32	BRRI dhan88	9.06	4.05
39	BRRI dhan80	6.25	2.36	BRRI dhan89	9.37	3.95
40	BRRI dhan87	7.14	1.90	BRRI dhan92	9.22	3.52
41	BRRI dhan90	5.12	1.35	BRRI dhan96	7.81	3.79
42	BRRI dhan91	5.14	1.11	BRRI dhan97	8.5	3.73
43	BRRI dhan93	6.74	2.44	BRRI dhan99	9.68	4.11
44	BRRI dhan94	6.65	2.50	Bangabandhu dhan100	10.14	4.08
45	BRRI dhan95	6.39	2.34	BRRI dhan101	9.15	5.15
46	BRRI dhan103	7.15	2.57	BRRI dhan102	8.88	3.75
47	BRRI hybrid dhan4	6.58	1.16	BRRI dhan104	8.44	4.64
48	BRRI hybrid dhan6	6.95	0.95	BRRI dhan105	9.42	4.86
49	-	-	-	BRRI hybrid dhan2	9.67	3.73
50	-	-	-	BRRI hybrid dhan3	9.52	3.02
51	-	-	-	BRRI hybrid dhan5	9.76	4.46
52	-	-	-	BRRI hybrid dhan8	9.97	5.21
Average		6.67	1.39	**Average**	8.89	2.86

Conclusion

T. Aman varieties, BRRI dhan49, BRRI dhan87 and BRRI dhan93 were found stable. None of the varieties were found to be unstable during T. Aman season. Among the aromatic rice BRRI dhan5, BRRI dhan34, BRRI dhan37 and BRRI dhan38 were found as below average stable in T. Aman season.

Boro varieties, BRRI dhan89, BRRI dhan101, and BRRI hybrid dhan8 were found as stable. BR3, BR9, BR14, BR15, BRRI dhan29, BRRI dhan55, BRRI dhan58, BRRI dhan59, BRRI dhan61, BRRI dhan67, BRRI dhan68 BRRI dhan69, BRRI dhan74, BRRI dhan86, BRRI dhan88, BRRI dhan92, BRRI dhan96, BRRI dhan97, BRRI dhan99, Bangabandhu dhan100, BRRI dhan102, BRRI dhan105, BRRI hybrid dhan2, BRRI hybrid dhan3 and BRRI hybrid dhan5 varieties were found as average stable and rest of the 25 varieties appeared to be below average stable. Among the non-aromatic rice. On the other hand, only aromatic rice BRRI dhan50 were found as below average stable.

In T. Aman varieties the average maximum and minimum yield was observed 6.67 t/ha and 1.39 t/ha respectively. The average maximum and minimum yield were observed 8.89 t/ha and 2.86 t/ha respectively in Boro varieties.

Study 1.2: Application of machine learning model for predicting rice yield loss concerning meteorological features in Bangladesh

-Md. Abdullah Al Mamun, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Aziz

Introduction

Agriculture, being the single largest sector of Bangladesh’s economy, may contribute to achieving the primary goal of economic development. Among different agricultural crops, Rice is Bangladesh’s major staple crop and, as such, is critical to the country’s food and nutrition security (Kabir et al., 2021). Therefore, Rice self-sufficiency has always been a top priority for governments. According to the Food and Agriculture Organization (FAO), Bangladesh is ranked third in the world in rice production (**FAO, 2022**). Machine learning has the potential to improve agriculture by changing the decision circumstance and producing the greatest crop yield projection. Several versions of ML models have been developed for SPI forecasting including artificial neural network (ANN), support vector regression (SVR), extreme learning machine (ELM), adaptive neuro-fuzzy inference system (ANFIS), M5 Tree (M5T), random forest (RF), linear genetic programming (LGP), least-square support vector regression (LSSVR), extremely randomized tree (ERT), multivariate adaptive regression spline (MARS), wavelet pre-processing integrated ML models and bio-inspired hybrid ML models. The predictions provided by machine learning algorithms will assist farmers in deciding which crop to cultivate in order to discover the greatest characteristics of attributes by adding adequate management for intended trait performance, taking into account aspects such as temperature, rainfall, RH (%), and so on.

Advancements in crop yield forecasting techniques have significantly improved the estimation of the interactive effects of weather factors on crop yield. These techniques predict crop yields based on weather variables observed during the crop growth period. Commonly referred to as "crop models," these tools are invaluable for crop planning, as they integrate multidisciplinary information, including edaphic factors (e.g., land use, soil properties, soil pH, fertility, and moisture), meteorological variables (e.g., temperature, rainfall, and relative humidity), management practices (e.g., row spacing, seed quantity, fertilizers, and pesticide use), and crop-specific factors (e.g., genotype × environment interactions). Crop models are generally classified into three categories based on their input requirements: empirical or statistical models, simulation models, and weather analysis models. These models rely on two fundamental approaches: traditional mathematical modelling and the application of artificial intelligence (AI) techniques. Historically, many studies have employed statistical methods, such as multiple linear regressions (MLRs), to develop crop yield prediction models. However, these models require careful application, as they are prone to overfitting due to the multicollinearity among independent variables (weather factors), which can lead to an overdependence of yield predictions on these factors. Data on rice cultivation area, production, and yield were analysed using statistical and machine learning techniques. The detrended analysis is applied to analyse the yield deviation from the trend mean, and we also use the Standardized Yield Residual Series (SYRS) to categorize yield losses across different rice-growing seasons in Bangladesh. The construction of a decision tree based on several meteorological parameters for determining yield loss could be a policymaking platform to combat yield rice loss.

Objectives

- To assess and categorize rice yield loss in different seasons in Bangladesh.
- To develop a machine learning model for predicting and classifying yield loss.
- To construct a decision tree based on several meteorological parameters for determining yield loss.

Materials and Methods

To achieve the study's objective, secondary data were utilized. Rice yield data for 64 districts in Bangladesh were gathered from various editions of the Yearbook of Agricultural Statistics. The data covered three rice-growing seasons—Aus, Aman, and Boro—as well as the total yield, spanning the period from 2006-2007 to 2022-2023, a duration of 17 years. This dataset included information related to rice cultivation area, production, and yield across Bangladesh. The statistical analysis of crop production was based on the average yields from all districts. Given the advancements in agricultural technology, such as increased fertilizer application, the introduction of new crop varieties, improved weed control, and enhanced tillage practices, rice production has generally shown an upward trend. To account for non-climatic factors and eliminate bias, a linear regression model was applied to remove the trend when assessing yield variability. The residuals from this analysis represent the effects of weather on yield and highlight deviations from normal weather conditions. To compare yield variability across crops with different mean values and standard deviations, yield residuals were standardized using the Z-score transformation. This method quantified the residuals in terms of how many standard deviations they were from the mean of the distribution. The following methods were employed in the analysis: Detrended analysis, Extreme Learning Machine (ELM), Standardized Yield Residual Series (SYRS), Adaptive Neuro-Fuzzy Inference System (ANFIS), Gradient Boosting Method (GBM), M5 Tree (M5T), Random Forest Classifier (RFC), Random Forest (RF), Artificial Neural Network (ANN), and Ranger. Microsoft Excel was used to organize and compile the secondary datasets. All statistical analyses were performed using R programming software. Spatial data were organized in district-level shapefiles, and the results were visualized using both R and ArcGIS 10.3 software for better interpretation and presentation of outcomes.

Results and discussion

District-wise rice yield trend in Bangladesh

It is crucial to understand the nature of rice yield across different seasons as well as at the aggregate level. This understanding will support the development of targeted, need-based government policies and strategies that are more effective in ensuring food security for the country. Using 17 years of time series data, we examined the relationship between rice yield and time across various districts of Bangladesh for each season and in total. The results show that, except for Rangamati, Cox's Bazar, and Khulna, most districts demonstrated a positive association between Aus rice yield and time (**Fig 7**). Among these, 60 districts showed a significant ($p \leq 0.05$) positive association. For Aman rice, all districts showed a positive correlation with yield, and 54 districts had a significant positive association (**Fig 8**). In the case of Boro rice, 46 districts exhibited a significant positive correlation with time, while Joypurhat and Pabna showed a negative correlation (**Fig 9**). When examining total rice yield, all districts displayed a positive association with time, with 48 districts showing a significant ($p \leq 0.05$) positive trend (**Fig 10**).

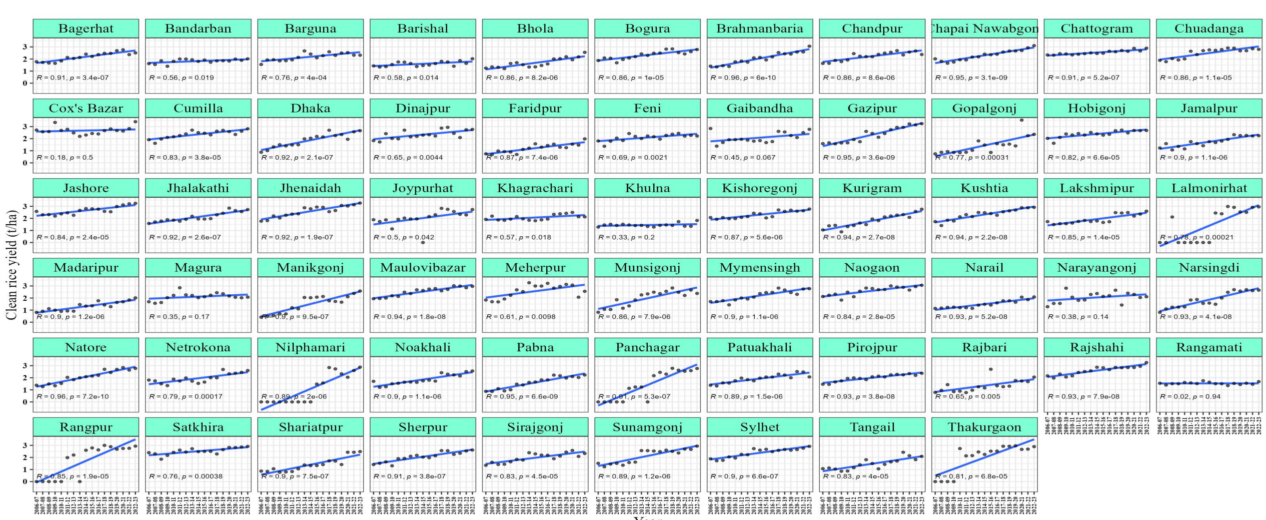


Fig 7: Trend of Aus rice yield of 64 districts of Bangladesh during 2006-07 to 2022-23.

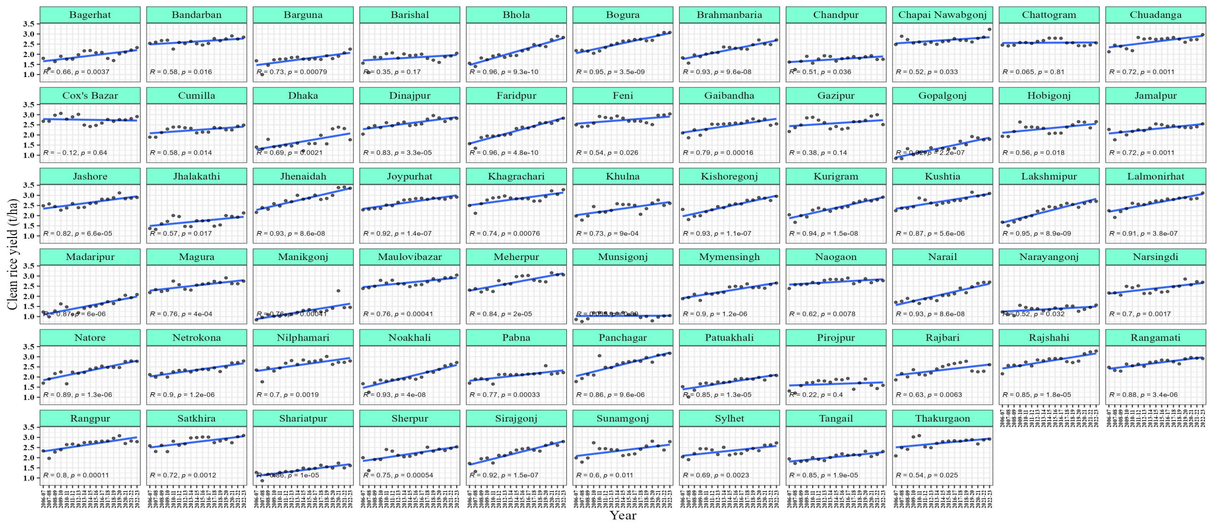


Fig 8: Trend of Aman rice yield of 64 districts of Bangladesh during 2006-07 to 2022-23.

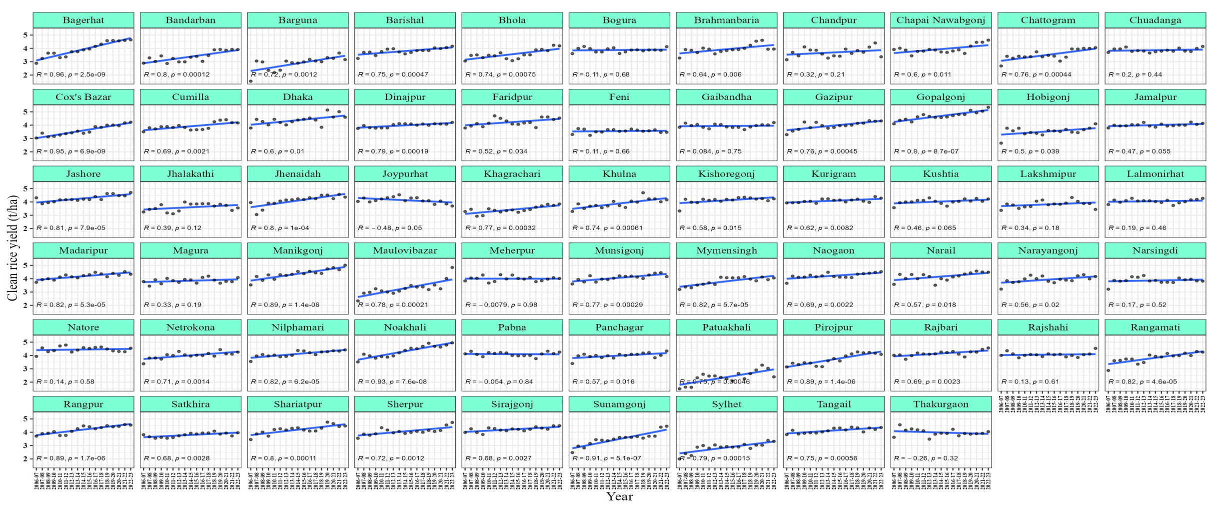


Fig 9: Trend of Boro rice yield of 64 districts of Bangladesh during 2006-07 to 2022-23.

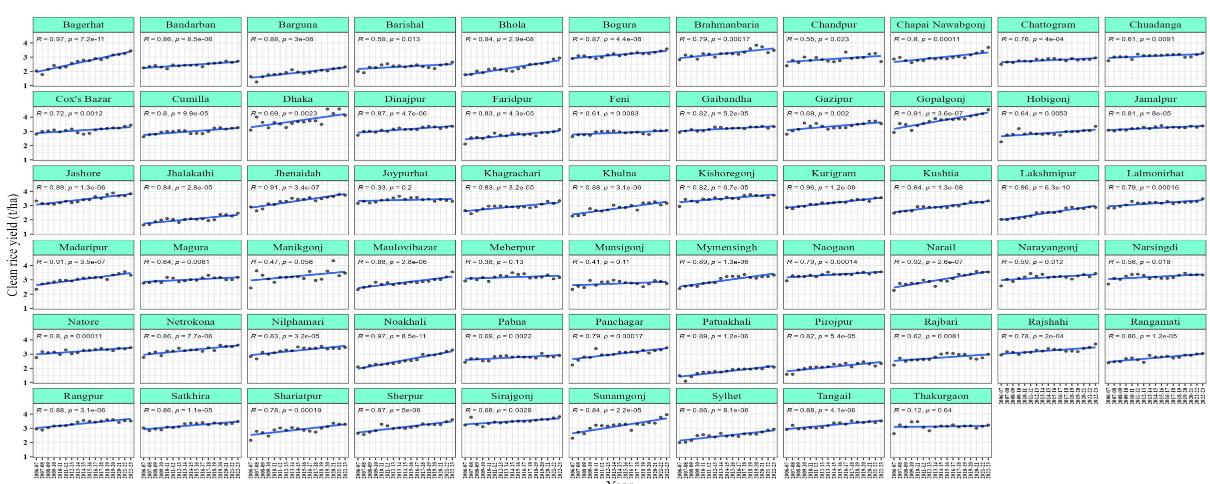


Fig 10: Trend of Total rice yield of 64 districts of Bangladesh during 2006-07 to 2022-23.

Spatial-temporal distribution of Standardized Residual Yield Series (SYRS) for different season

Evolution of SYRS: To account for the presence of a trend, the time series data on rice yield was detrended. The detrended SYRS (Standardized Yield Residuals Series) results revealed district-wise variations in rice yield across different seasons in Bangladesh (Fig 5). This study analyzed 17 years of rice yield data to calculate the yield loss years (SYRS ≤ -0.51). Using the SYRS equation, we determined the yield loss years for each season across all study districts. The temporal evaluation of the standardized yield residual series (SYRS) of different rice season for 64 districts over 17 years are shown in **Fig. 11-14.** According to the threshold values in Table 1, SYRS as a detrended yield with values ranging less than or equal to −1.50 (high yield losses) to more than or equal to 1.50 (high yield increment). The years with high yield losses for Aus, Aman, Boro and Total rice yield were depicted in **Fig 11-14**.

Aus season

For the Aus season, yield loss years ranged from 2 to 7 out of the 17 study years, depending on the district. The highest yield loss of seven years was observed in Barishal, Barguna, Chuadanga, Khagrachari, Maulvibazar, Noakhali, Sirajganj, and Thakurgaon. Across the 64 districts, 21 districts experienced a five-year yield loss, 18 districts had a four-year yield loss, 2 districts faced a three-year yield loss, and 1 district had a two-year yield loss (**Fig 11**). The figure 9 presents spatiotemporal variability in rice yield on the Aus rice season in Bangladesh from 2006-07 to 2022-23, categorizing the performance of districts based on yield losses and increments. The high yield loss category shows peaks in 2009-10 and 2015-16, where 8 districts experienced significant losses, while other years like 2007-08 and 2014-15 had moderate high yield losses. Moderate yield losses were highest in 2007-08 with 10 districts affected, followed closely by 2009-10 and 2015-16, each with 9 and 7 districts, respectively. Low yield loss peaked in 2009-10, with 14 districts affected. On the positive side, most years saw a large number of districts with normal yields, particularly in 2012-13 and 2008-09, where 39 and 34 districts respectively experienced average yields. In terms of yield increments, the low yield increment category showed the highest values in 2014-15 and 2017-18, with 16 districts seeing minor yield improvements. Moderate yield increments were also highest in 2013-14 and 2017-18, each with 10 and 12 districts experiencing moderate growth. High yield increments were most notable in 2013-14 and 2017-18, with 13 and 10 districts respectively showing significant yield gains. Overall, the data suggest that while some years experienced considerable yield losses, others saw stability with normal yields and moderate improvements, especially in later years (**Fig 16**). The most significant yield growth was sporadic, with only a few districts consistently showing large gains.

Aman season

In the Aman season, yield losses across different districts ranged from 3 to 8 years. Nineteen districts experienced a six-year yield loss, 24 districts had a five-year loss, 12 districts faced a four-year loss, and 6 districts recorded a three-year yield loss (Fig 6). Figure 9 also presents the spatiotemporal variability of Aman rice yield in Bangladesh from 2006-07 to 2022-23, highlighting key trends in district-wise performance. The year 2007-08 saw the highest number of districts (23) experiencing high yield loss, with other notable years being 2018-19 (5 districts), 2019-20 (6 districts), and 2017-18 (3 districts). Most other years experienced only 1-2 districts with high yield losses, reflecting more stability. Moderate yield losses were again highest in 2007-08, with 12 districts affected, while 2019-20 and 2016-17 each saw 10 districts with moderate losses. Low yield losses were frequent, peaking at 18 districts in 2008-09 and 15 districts in 2021-22, with most years having districts affected by minor losses. On the other hand, normal yields were predominant in the later years, particularly in 2017-18 (32 districts), 2018-19 (31 districts), and 2022-23 (30 districts), reflecting increasing stability in yield performance. Yield increments, both low and moderate, were generally less common. However, 2011-12 and 2012-13 had 19 and 15 districts, respectively, experiencing low yield increments. High yield increments were concentrated in a few years, such as 2009-10 (13 districts), while most other years saw limited yield growth. Over time, the trend suggests that significant yield losses were concentrated in 2007-08 and 2008-09, but the frequency of normal yields increased in recent years, pointing to some stabilization in the Aman rice yield, though large gains in yield increments remained infrequent (Fig 15).

Boro season

During the Boro season, yield loss categories varied from 3 to 8 years. Gaibandha district experienced the highest yield loss, with eight years of loss. Four districts faced a seven-year loss, while 20 districts had a six-year loss, 16 districts a five-year loss, 20 districts a four-year loss, and 3 districts a three-year loss (**Fig 13**). The result illustrates the performance of spatiotemporal variability of Boro rice yields across various districts in Bangladesh from 2006-07 to 2022-23, categorized by yield losses and yield increments (**Fig 15**). The high yield loss was most significant in 2006-07, affecting 22 districts, which was an outlier compared to all other years. Smaller peaks in high yield losses occurred in 2018-19 with 5 districts and 2020-21 with 4 districts. Moderate yield losses were prevalent in 2006-07 and 2018-19, where 14 and 9 districts were impacted, while most other years saw fewer districts with moderate losses. Low yield losses were highest in 2015-16 and 2021-22, with 15 districts each, indicating relatively widespread small losses in those years. However, years like 2010-11 and 2011-12 saw only 5 districts impacted, suggesting more stability. Normal yields were most common in 2016-17 and 2019-20, with 32 and 33 districts experiencing stable conditions, indicating strong overall performance in these years. Regarding yield increments, low yield increments peaked in 2007-08 and 2010-11, with 16 districts each showing slight improvements. Moderate yield increments were highest in 2007-08, affecting 11 districts, and high yield increments were most significant in 2007-08, with 14 districts seeing large yield gains, far surpassing other years. Overall, the data suggest that while 2006-07 was a challenging year with widespread yield losses, subsequent years, especially 2016-17 and 2019-20, saw more stability and improvement in Boro rice yields across Bangladesh, with notable positive increments in 2007-08 (**Fig 16**).

Total season

Overall, Magura district experienced an eight-year yield loss for total rice yield over the 17 years. Five districts faced a seven-year yield loss, 16 districts a six-year loss, 18 districts a five-year loss, 15 districts a four-year loss, 6 districts a three-year loss, and 2 districts faced a two-year loss (**Fig 8**). Spatiotemporal variability of yield loss and gain are presented in Figure 9. In the case of total rice yield, High yield loss was particularly notable in 2006-07, with 20 districts experiencing significant losses. Subsequent years saw fewer districts with high yield loss, such as 2018-19, which had 6 districts affected. Moderate yield losses peaked in 2018-19 with 10 districts affected, but were generally low, particularly in years like 2010-11 and 2011-12, with only 2 districts each. Low yield losses varied more widely, with a maximum of 13 districts affected in 2008-09 and 2016-17. Regarding normal yield conditions, most years saw a majority of districts experiencing stable yields, particularly 2015-16 and 2019-20, when 33 and 32 districts respectively reported normal yields. This suggests relative stability in rice production in these years. Low yield increments were generally moderate, peaking at 20 districts in 2012-13, while moderate yield increments reached a high of 11 districts in 2013-14. High yield increments were rare but peaked in 2013-14, when 12 districts saw significant gains. 2010-11 and 2011-12 also had notable high yield gains, affecting 10 districts each. Overall, the data indicates that rice yields were most stable in 2015-16 and 2019-20, with more districts reporting normal yields and fewer experiencing significant losses. Yield increments, particularly high and moderate gains, were less frequent but varied across the years, with 2013-14 showing the most widespread high yield gains (**Fig 16**).

Relative influence of various climatic factors

Figure 11 illustrates the relative influence of various climate and environmental factors on rice yield across three seasons: Aus, Aman, and Boro and the total yield in Bangladesh. The analysis reveals that SPEI (Standardized Precipitation-Evapotranspiration Index), which measures drought conditions, is the most critical factor affecting rice yields across all seasons. July, August, and May show the highest influence depending on the rice type. For Aus rice, SPEI in July and June dominates, reflecting the importance of monsoon moisture. Aman rice is most sensitive to SPEI in August and October, corresponding to its growing and maturing stages. Boro rice, cultivated during the dry season, is influenced by SPEI in February through May, with May having the strongest effect as it coincides with the harvest period. Additionally, relative humidity (RH) consistently plays a significant role in all seasons, indicating its critical influence on creating favorable growing conditions. Factors like wind speed (WS) and temperature extremes (Tmax) also contribute to yield variability, though their effects are less dominant (**Fig 17**). Overall, the results highlight the need for climate-adaptive strategies, which strongly focus on managing drought risks and ensuring optimal humidity levels across rice-growing periods.

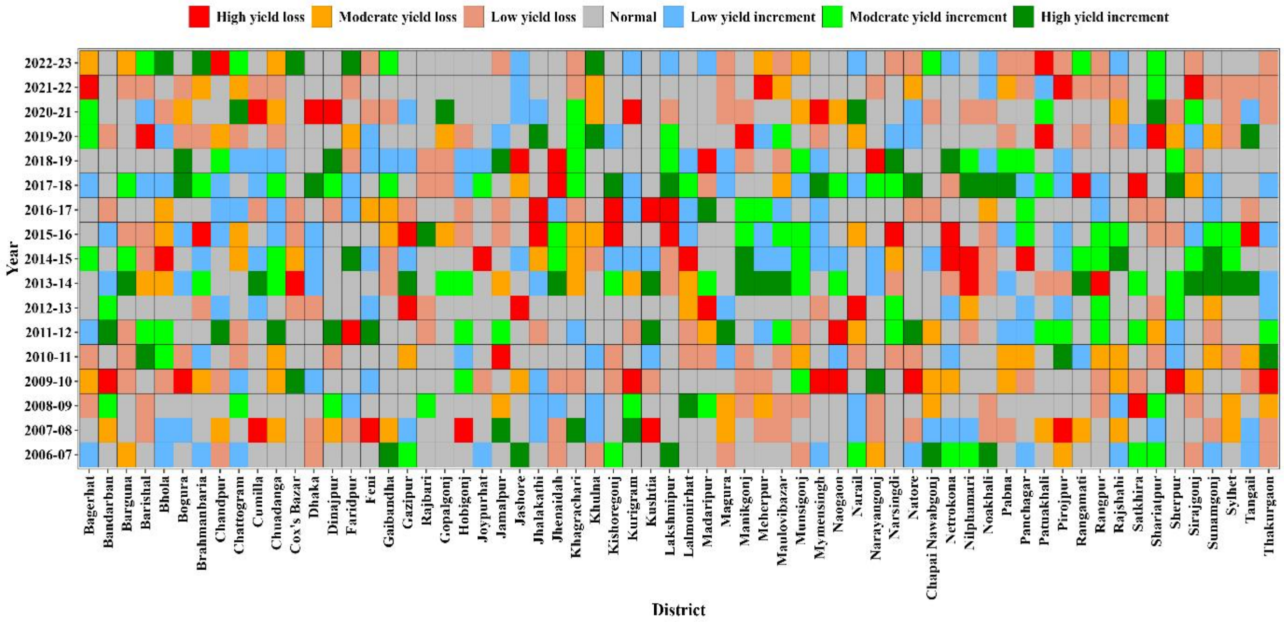


Fig 11: Heatmap of different types of yield loss/gain of 64 districts of Bangladesh during 2006-07 to 2022-23 in the Aus season.

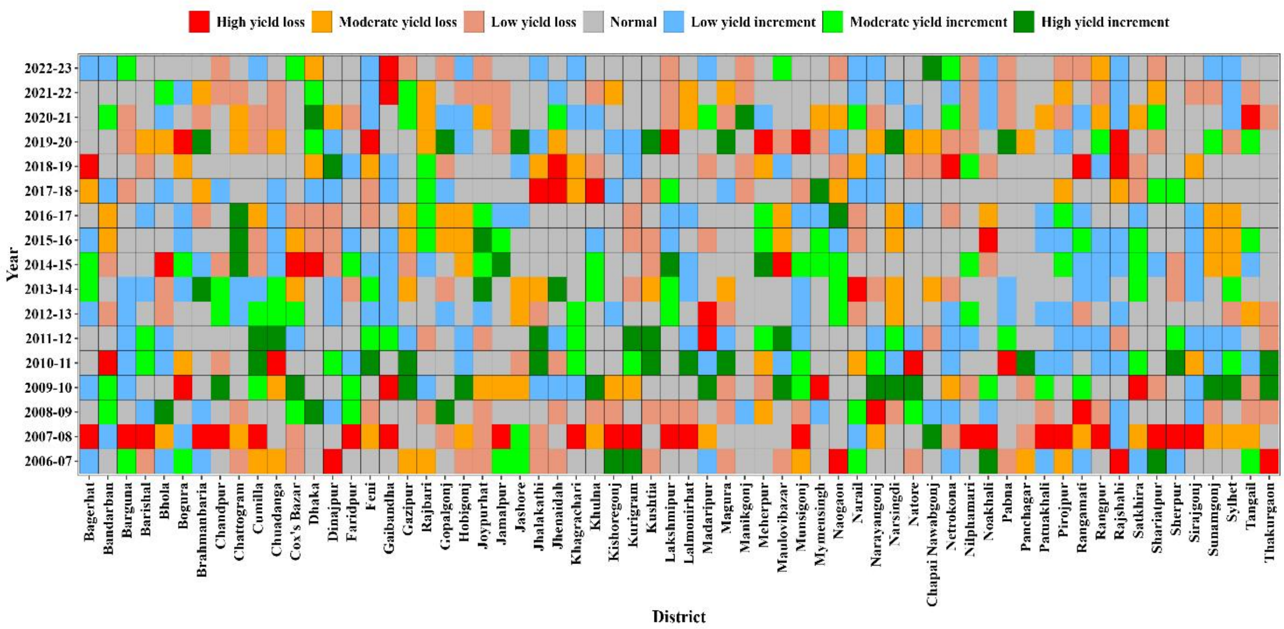


Fig 12: Heatmap of different types of yield loss/gain of 64 districts of Bangladesh from 2006-07 to 2022-23 in the Aman season.

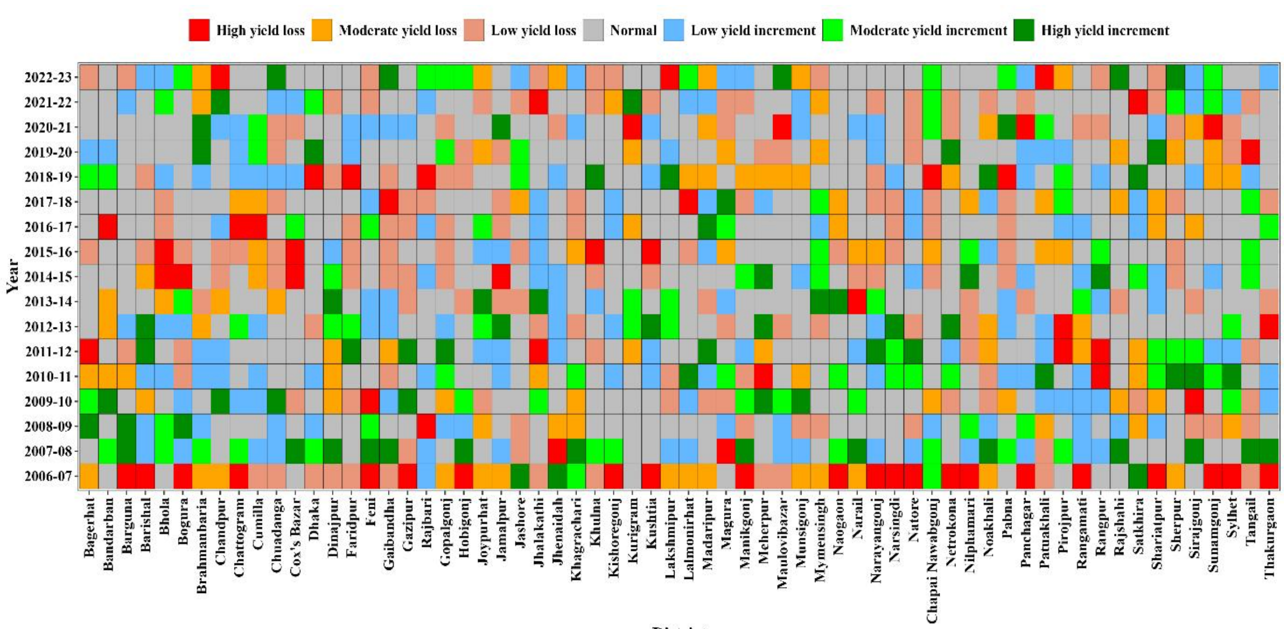


Fig 13: Heatmap of different types of yield loss/gain of 64 districts of Bangladesh from 2006-07 to 2022-23 in the Boro season.

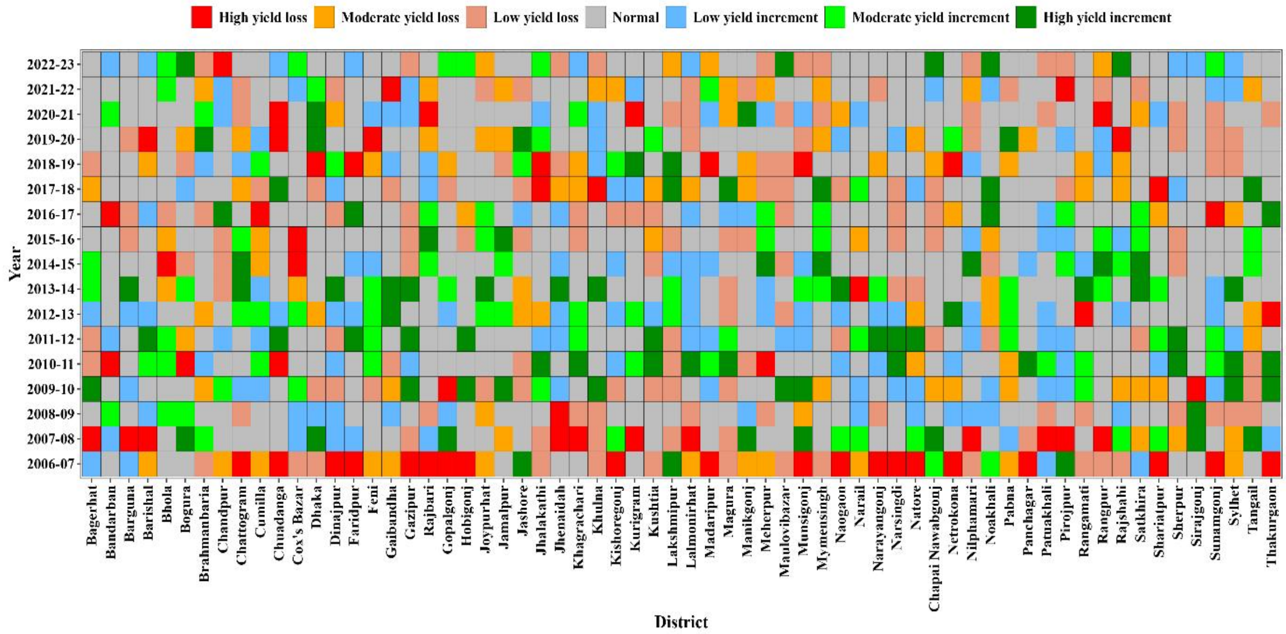


Fig 14: Heatmap of different types of yield loss/gain of 64 districts of Bangladesh during 2006 07 to 2022-23 in Total season.

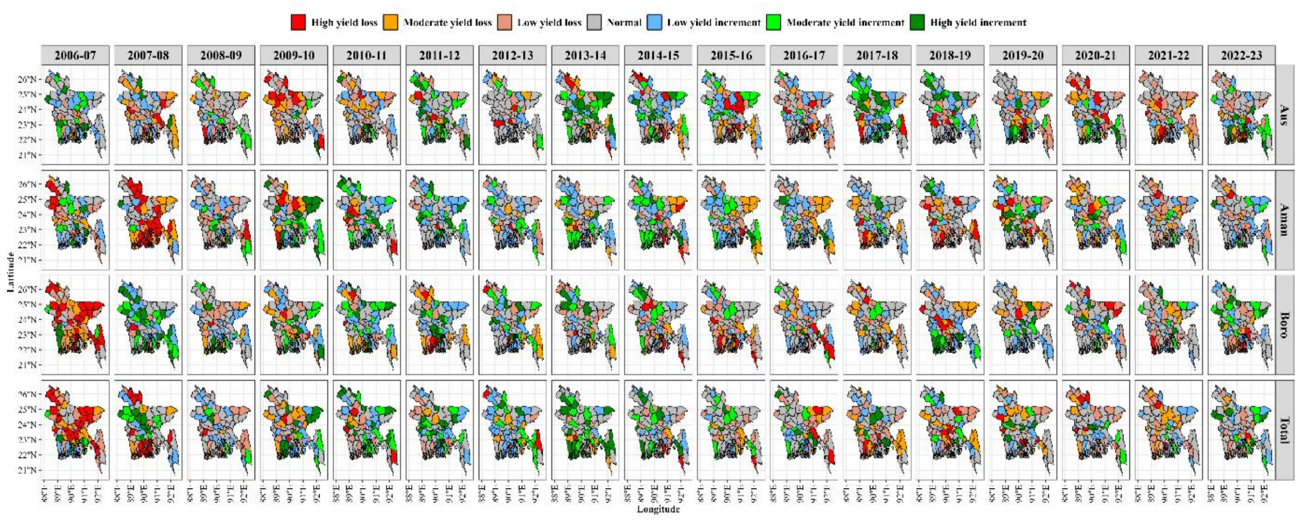


Fig 15: Spatial changes in Standardized Residual Yield Series (SYRS) for different rice season (a) Aus, (b) Aman (c) Boro and (d) Total rice in Bangladesh from 2006-07 to 2022-2023.

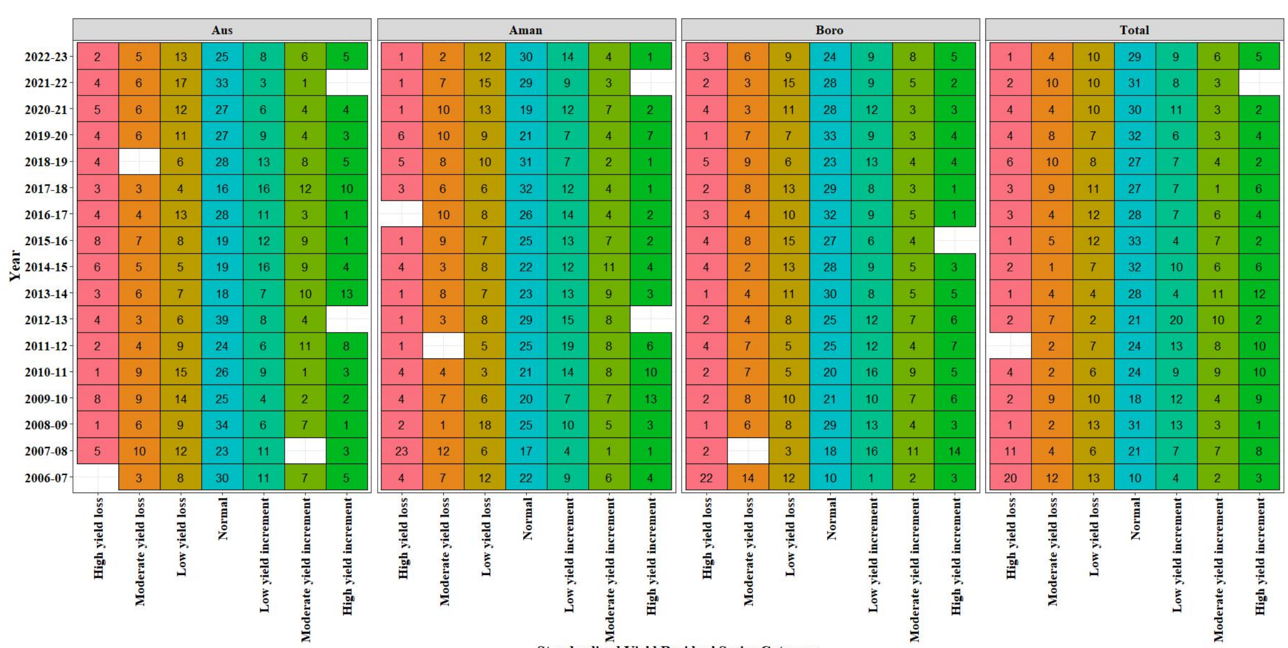


Fig 16: Heatmap of the frequency (no. of districts) of different types of yield loss/gain of 64 districts of Bangladesh during 2006-07 to 2022-23 in Aus, Aman, Boro and Total season.

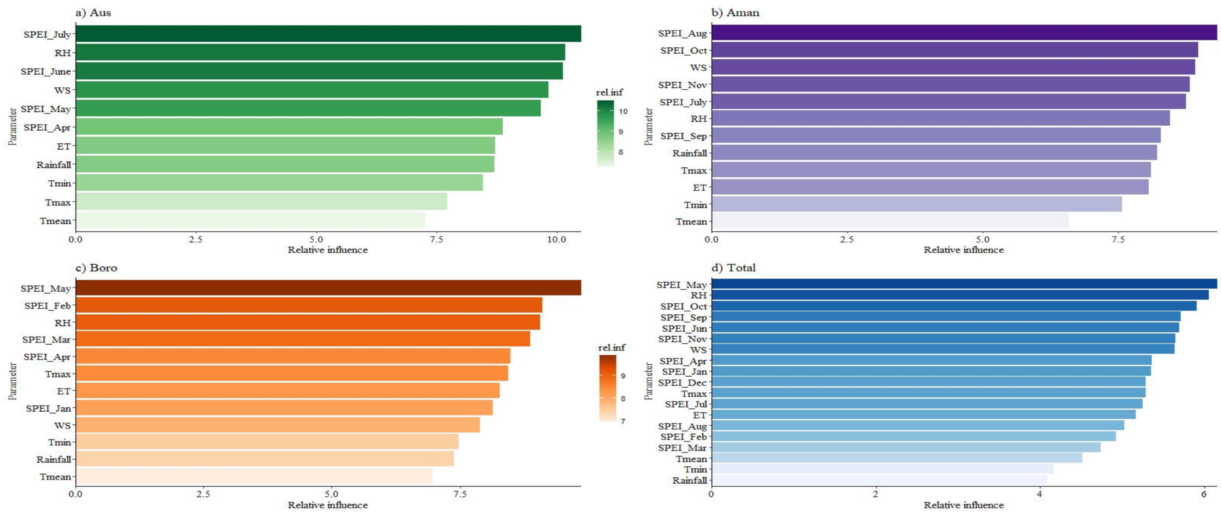


Fig 17: Relative influence of various climate and environmental factors on yield loss/gain in Aus, Aman, Boro, and Total seasons.

Conclusion

The district-wise analysis of rice yield trends in Bangladesh reveals a general improvement in rice production over time, with some districts consistently performing well, while others continue to face challenges. Aus and Aman rice yields have shown more sporadic improvements than Boro rice, which faced more significant yield losses in specific years. Total rice yield trends indicate relative stability in recent years, encouraging long-term food security planning in the country. SPEIs of different times are the most influential factor affecting rice yields in Bangladesh, emphasizing the importance of monsoon moisture for Aus, sensitivity to late-season SPEI for Aman, and dry season management for Boro. Additionally, relative humidity significantly impacts yields across all seasons, stressing the need for climate-adaptive strategies to manage drought risks and optimize humidity levels. Also, from the study, proposed models (Ensem_svm_ranger, Ensem_rf_svm_ranger and Ensem_all_ML) has found best models for yield prediction for different rice growing seasons of Bangladesh.

Project 2: Multivariate analysis of BRRI varieties

Activity 2.1: Genotype X Environment Interaction of BRRI Varieties

(In collaboration with Pl. Breeding Div., ARD Regional Stations)

-Md. Abdullah Al Mamun, Md. Ismail Hossain, Md. Shahjahan Kabir, Niaz Md. Farhat Rahman, Md. Abdul Qayum, Md. Abdullah Aziz, Md. Asadullah and One Scientist from each Regional Station

Introduction

Rice is the main staple food in Bangladesh, occupies nearly 80% of the total net cropped area (Hossain *et.al*, 2015). Development and adaption of high yielding cultivars under wide range of diversified environments is one of the major goals for the plant breeders in crop improvement programme (Boseet.al, 2015). The development of rice varieties is affected by the environment, genotype and their interaction. Yield performance of different varieties varies across testing environments and its grain yield performance is a function of genotype (G), environment (E) and genotype × environment interaction (GEI). The structure of GEI is very important in plant breeding programs because a significant GEI can seriously impair efforts in selection of superior genotypes in relation to new crop introductions and cultivar development programs leads to successful evaluation of stable genotype, which could be used for general cultivation (Yan and Racjan, 2002; Vasgas et al. 2001; Reza et al.2007).

Objective

The major objective of the study was to identify BRRI released rice genotypes that have both high mean yield and stable yield performance across different environments for different ecosystem of Bangladesh.

Materials and Methods

The experiment was conducted in multi-environment trials for T. Aman 2023. Forty-eight (48) BRRI released T. Aman rice varieties were evaluated in nine environmental conditions of Bangladesh, such as Barishal, Bhanga, Cumilla, Gazipur, Kushtia, Rajshahi, Rangpur, Satkhira, and Sonagazi. The experimental sites covered all ecosystems of Bangladesh. The experiments were carried out in randomized complete block design (RCBD) with three replications and evaluated for rice grain yield. Each experimental plot comprised of 3m × 2m. Standard agronomic practices were followed and plant protection measures were taken according to Adhunik dhaner chash, BRRI (2023). AMMI model was used to quantify the effect of different factors (genotype, location) of the experiment. The model further provides graphical representation of the numerical results (GGE biplot analysis) with a straight-forward interpretation of the underlying causes of G × E.

Results and discussion

ANOVA of combined analysis

The combined analysis revealed that the yield of rice genotypes was significantly influenced by the environment and contributed 69.11, 65.74, and 62.28% of the total variation for short, medium, and long duration, respectively, in the Aman season. Additionally, the relative contribution of the genotype sum of squares was found to be 18.51, 14.75, and 9.48% for long, short, and medium duration, respectively. Genotype by environment (G × E) contributed the most 15.55% to the total variation for medium duration, followed by 14.08% and 12.06% for long and short duration (Table 4). The greater portion of the total variation was explained by the environmental main effect, indicating that the environments were diverse and a major part of the variation in grain yield was reflected by environmental changes. The highly significant genotype × environment interaction effects for grain yield confirmed that genotypes responded differently to the variation in environmental conditions. The yield variations could be attributed to the different environmental (climatic) conditions and different edaphic conditions at different locations. In this case, the application of stability analysis for identifying wide and/or specific adaptations of rice genotypes is essential.

Table 4. ANOVA of individual category (long, medium and short duration) Aman 2023.

SV	Long duration			Medium duration			Short duration		
	DF	MS	SS (%)	DF	MS	SS (%)	DF	MS	SS (%)
ENV	8	72.49**	62.28	8	51.73**	65.74	8	73.90**	69.11
REP(ENV)	18	0.35**	0.69	18	0.59**	1.71	18	0.28**	0.58
GEN	17	10.13**	18.51	13	4.78**	9.48	15	8.41**	14.75
ENV:GEN	136	0.96**	14.08	104	0.94**	15.55	120	0.86**	12.06
Residuals	306	0.13	4.44	234	0.19	7.12	270	0.11	3.50
CV (%)	9.32			9.40			7.46		
$LSD_{0.05}$	0.59			0.70			0.54		

Note: ENV=environment, GEN= genotype, DF = degrees of freedom; MS = mean sum square; SS (%) = explain % sum of squares; ** = significant at 1% level.

Performance and stability of rice genotypes across tested environments

Aman season:

The GGE biplot explained 84.97%, 78.81%, and 72.62% of the total variation of the environments for long, short, and medium duration, respectively (Fig. 18-21). Within a single mega-environment, genotypes should be evaluated on both mean performance and stability across environments. Figures 18a, 19a and 20a shows average-environment coordination (AEC) views of the GGE biplot for grain yield of long, medium, and short duration. Fig. 18-21 shows the yield performances and summary of ideal genotypes and genotypes with stable and high mean yields in different categories (long, medium and short duration). BR11 recorded the highest average grain yield (5.43 t/ha) in long duration (Fig. 18a). BR10, BR22, BRRI dhan30, BRRI dhan40, BRRI dhan77 were the above-average yields (3.94 t/ha). Thus, the BR11, BRRI dhan30 was the most ideal genotype with the highest mean yield and stability among the tested genotypes (Fig. 18a). The genotype BRRI dhan103 (5.32 t/ha), BRRI dhan94 (5.06 t/ha), BRRI dhan51 (5.02 t/ha), BRRI dhan49 (4.93 t/ha), BRRI dhan93 (4.87 t/ha), BRRI dhan52 (4.80 t/ha) were the most stable genotype with above-average yield (4.65 t/ha) in medium duration (Fig. 19a). BRRI dhan87 (5.31 t/ha), BRRI dhan72 (5.06 t/ha), BRRI Hybrid dhan6 (5.01 t/ha), BRRI Hybrid dhan4 (4.97 t/ha), and BRRI dhan95 (4.95 t/ha) recorded the above-average yields among short duration variety. Among high yielded variety the BRRI dhan87, BRRI dhan72, and BRRI Hybrid dhan4 showed the closest position from the axis line, and designated as most stable and ideal genotype in short duration (Fig. 20a). Also, BRRI Hybrid dhan6, BRRI dhan95 were the moderately stable genotypes and above average yielder (Fig. 21).

Identification of which-won-where and mega-environment

One of the most attractive features of a GGE biplot is its ability to show the which-won-where pattern of a genotype by environment dataset. This plot consists of a polygon with perpendicular lines, called equality lines, drawn onto its sides. These lines divide the polygon into various sectors. Genotypes located on the vertices of the polygon are the best performers in one or more environments falling within a particular sector.

The biplot showed two sectors containing all the test environments in long duration, and accordingly, two mega-environments were identified (Fig. 18b): One mega-environment had seven locations: Gazipur, Bhanga, Cumilla, Kushtia, Barishal, Rangpur, and Sonagazi; the second consisted of two locations: Rajshahi and Satkhira. Hence, the winning genotype in those environments was BR11 for first; BR10 is the second location (Fig. 18b).

In medium duration, the biplot grouped the test locations into three mega-environments (Fig. 19b). The first mega-environment had three locations, Sonagazi, Barishal, and Gazipur. The second had one location was Cumilla. The third contained five locations Bhanga, Satkhira, Rajshahi, Kushtia and Rangpur. BRRI dhan94 and BRRI dhan52 were the winning genotype in the first mega-environment while BRRI dhan103 was the winner in the second mega-environment.

The biplot was divided into four mega-environments in short duration (Fig. 20b). The first mega-environment had three locations- Gazipur, Barishal and Rangpur with BRRI dhan95 being the winning genotypes. The second mega-environment had three locations-Kushtia, Bhanga and Cumilla where BRRI dhan72 was the winner in this mega-environment. The third mega environment had three locations: Rajshahi, Satkhira, and Sonagazi, where BRRI dhan87 and BRRI Hybrid dhan6 were the winning genotypes for short duration.

Evaluation of test environments

In long duration (Fig. 18), there were three clusters of environments, one contains Barishal, Bhanga, Gazipur, Cumilla and Sonagazi; another contains Kushtia, Rajashahi and Satkhira; the other cluster contains only, Rangpur. Among them Cumilla and Bhanga were closely associated (Fig.18c). Rajshahi and Rangpur had the longest vector and hence was highly discriminating. Overall, the locations Kushtia was highly representative and can be considered ideal environments for evaluating long duration genotypes (Fig.18c). GGE biplot showed four distinct clusters in medium duration: one contains Bhanga and Satkhira; another cluster contains Kushtia and Rangpur; Rajshai, Sonagazi and Barishal had another cluster; and Gazipur and Cumilla remain same cluster (Fig. 19c). The closest association were observed between the environments Bhanga and Satkhira. The ideal environment was found Rangpur and Kushtia (Fig. 19c). for testing medium duration genotypes with its appreciable discriminating ability and representativeness and position nearest to the circle point of AEA (average-environment axis).

In short duration GGE biplot showed three distinct clusters (Fig. 20c). Barishal, Rangpur, and Gazipur considered one cluster and the second cluster contains Kushtia, Cumilla and Bhanga and the rest cluster contain another three locations Rajshahi, Sonagazi and Satkhira. Satkhira showed the longest vector, making it more discriminating than the other environments. Considering the criteria of ideal environment, Kushtia and Cumilla showed a smaller angle with the AEA and hence highly representative environment (Fig. 20c) for testing short duration genotypes.

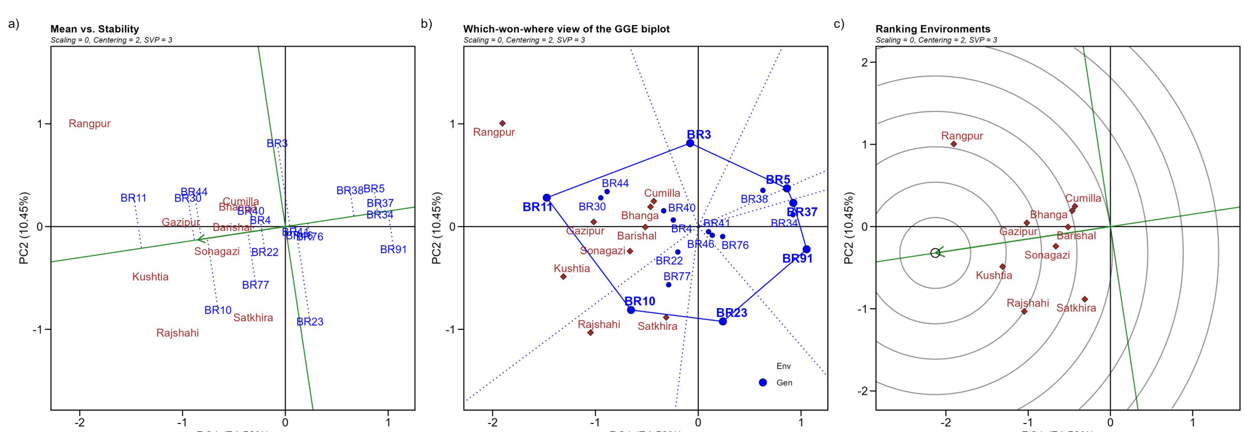


Fig. 18: GGE biplot of mean and stability (a), GGE biplot identification of winning genotypes and their related mega-environments (b) and association among the test environments (c) of long duration rice genotypes for yield and specific genotype × environment interactions in T. Aman 2023.

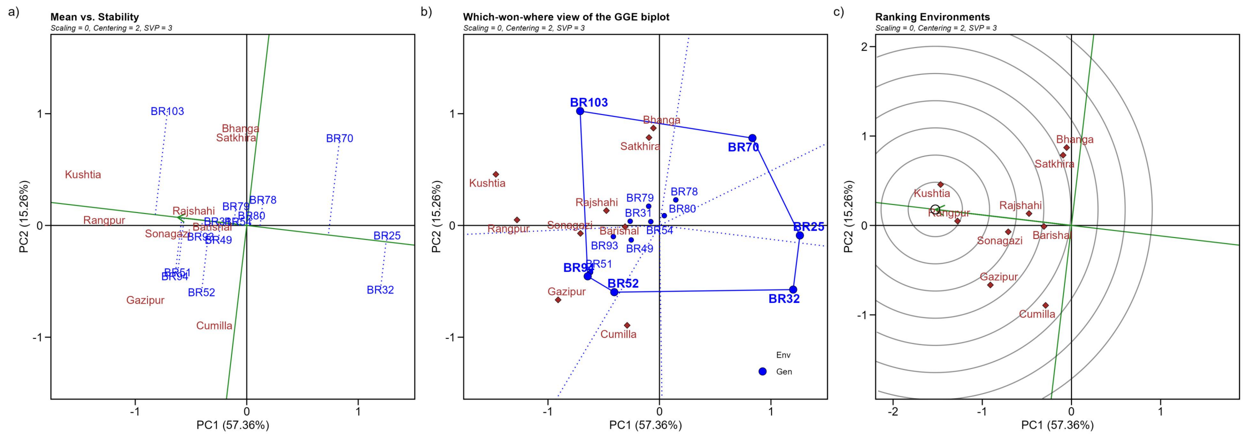


Fig. 19: GGE biplot of mean and stability (a), GGE biplot identification of winning genotypes and their related mega-environments (b) and association among the test environments (c) of medium duration rice genotypes for yield and specific genotype × environment interactions in T. Aman 2023.

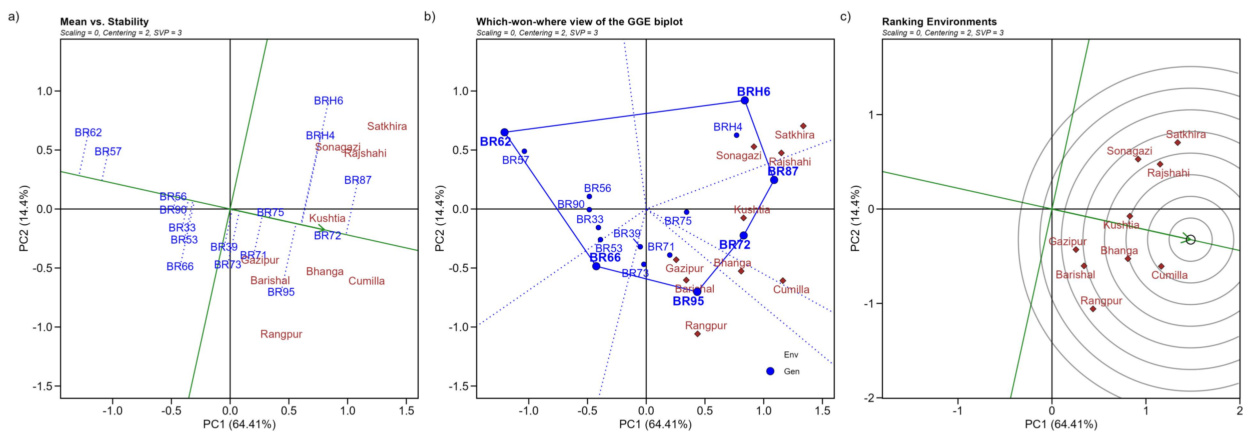


Fig. 20: GGE biplot of mean and stability (a), GGE biplot identification of winning genotypes and their related mega-environments (b) and association among the test environments (c) of short duration rice genotypes for yield and specific genotype × environment interactions in T. Aman 2023.

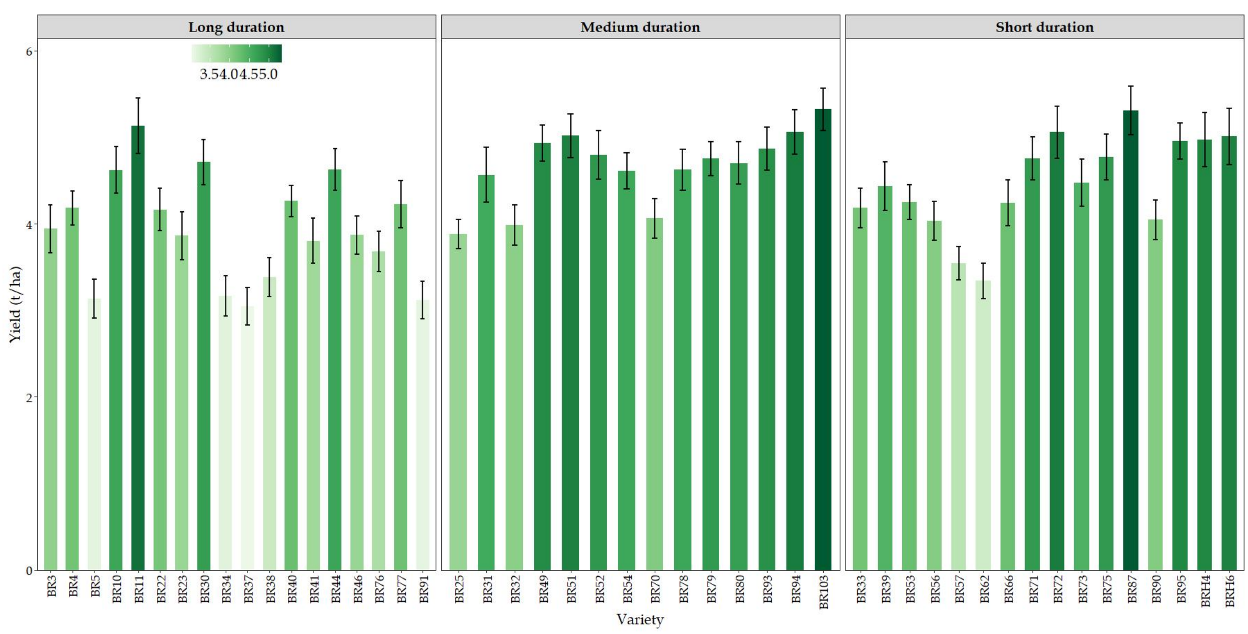


Fig. 21: Grain yield performance of BRRI released T. Aman rice varieties during 2023.

Conclusion

The highly significant genotype × environment interaction effects for grain yield confirmed that genotypes responded differently to the variation in environmental conditions for long, medium, and short-duration Aman varieties. The greater portion of the total variation was explained by the environmental main effect, indicating that the environments were diverse and a major part of the variation in grain yield was reflected by environmental changes. In the Aman season, BR11 and BRRI dhan30 recorded the highest average grain yielder and ideal genotypes among long-duration varieties. BRRI dhan103, BRRI dhan94, BRRI dhan51, and BRRI dhan49 were the most stable genotypes with above-average yield in medium duration, where BRRI dhan87, BRRI dhan72, BRRI Hybrid dhan6, BRRI Hybrid dhan4 and BRRI dhan95 were the most stable genotypes and above average yielder for short duration.

Project 3: Rice and Rice Related Database

Activity 3.1: Database management and visualizations of demonstration data for BRRI

- Md. Ismail Hossain, Md. Assadullah , Md. Abdul Qayum, Md. Abdullah Aziz and Md. Abdullah Al Mamun

Introduction

Effective database management and visualization are critical for the successful analysis and dissemination of research data. In the context of the Bangladesh Rice Research Institute (BRRI), managing demonstration data involves handling complex datasets that track agricultural practices, experimental results, and key metrics for rice cultivation. These datasets provide valuable insights into crop yield and the impact of various interventions. To fully leverage the potential of this data, robust database systems and visualization tools are necessary. Database management ensures the integrity, security, and accessibility of the data, allowing researchers to store, query, and retrieve information efficiently. Demonstration information increase awareness in the farmer's community about a new rice variety. The demonstration information need not only creating awareness among farmers about modern technologies but also motivated them to apply these in their farming practices. It provides very important information for policy making. The objective of this demonstration will be popularize and demonstrate the newly released rice variety. This database management technology used to manage demonstration data for BRRI, emphasizing the integration of database systems with advanced visualization techniques. Demonstration information increase awareness in the farmer's community about a new rice variety. The demonstration information need not only creating awareness among farmers about modern technologies but also motivated them to apply these in their farming practices. It provides very important information for policy making. The objective of this demonstration were popularize and demonstrate the newly released rice variety.

Objectives

- To develop a database management system of demonstrations for different divisions and regional stations..
- To identify the impact of BRRI varieties expansion on growth rate
- To generate report and visualize for demonstrations results.

Materials and Methods

Demonstration information contribute significantly to rice related research specially for new varieties and technology. To develop and maintain this database, the following programming Languages used

- Excel (data entry and data format)
- R Studio (For analytical process)
- MySQL (Relational Database)
- R-Shiny
- Shiny web server
- Apache web server

Results and Discussion

We already developed a dashboard and database using rice and rice related data. First we developed a frame of the dashboard structure and MYSQL database. In this dashboard included 5 tab and under each tab sever sub menu. The database successfully integrates multiple datasets from different sources. The primary data categories include crop yield and weather patterns data. A user-friendly interface was developed, allowing researchers to query and update data with minimal technical expertise. The system supports continuous data inflow, ensuring future expansion as demonstration trials increase. An overview of the develop dashboard depicted as below.

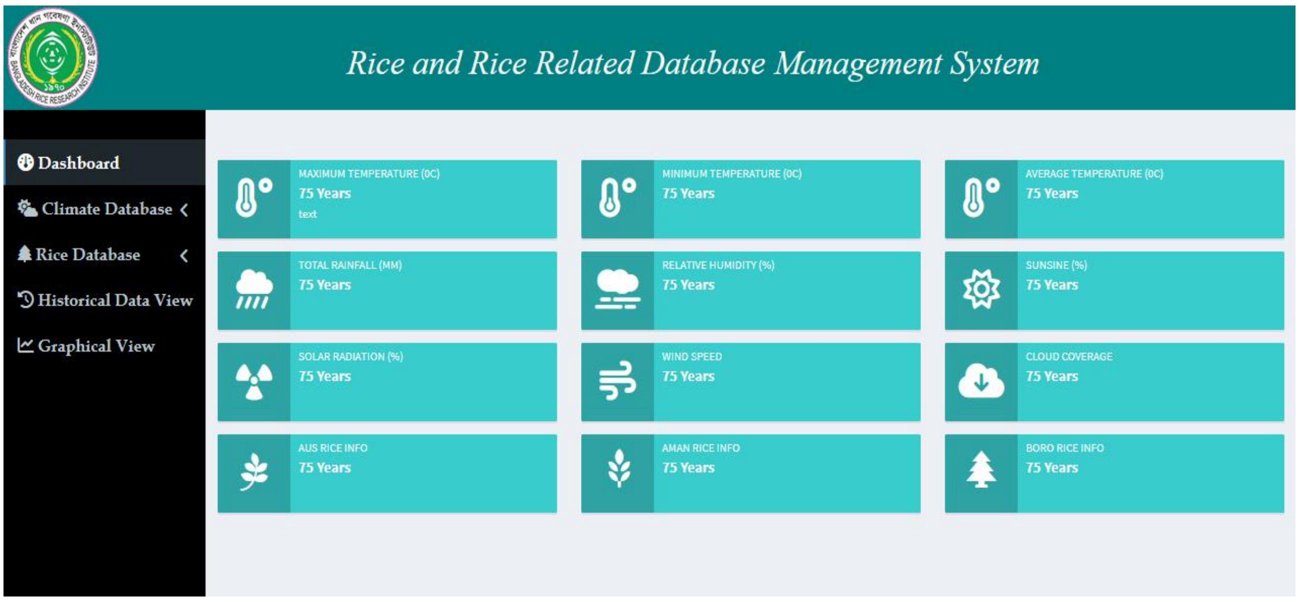


Fig 22: Database management and visualization System

Conclusion

The database management and visualization system significantly enhanced BRRI's ability to manage, analyze and interpret demonstration data. It supports evidence-based decision-making and the way for improved rice production strategies in Bangladesh. Visualization tools were integrated into the database system to transform raw data into comprehensible visual formats.

Activity 3.2: Maintenance of rice and related database

- Md. Ismail Hossain, Md. Abdul Qayum, Md. Abdullah Aziz, Md. Abdullah Al Mamun and Md. Assadullah

Introduction

Database management and maintenance are essential for the successful analysis of research data. Then, BRRI managing the rice and rice related experimental research data, experimental results for rice cultivation. These database provide valuable insights into rice crop yield and the impact of various interventions. Database management ensures the integrity, security, and accessibility of the data, allowing researchers to store, query, and retrieve information efficiently. So, our objectives are-

Objectives

1. To maintain up-to-date computerized information on rice and related crops
2. To provide rice and related information to other research divisions and interested persons.

Methodology

Secondary data on rice and other important crops were collected periodically from Bangladesh Bureau of Statistics (BBS), Agricultural Marketing Directorate, Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), Bangladesh Agricultural Development Corporation (BADC) and other sources periodically and computerized. We have initiated a database system where we used updated software and database program. To make this database, we were used **SQL Server** 2005 express edition/2008/2010/2012 version and **Oracal** 9i/10g/11i version.

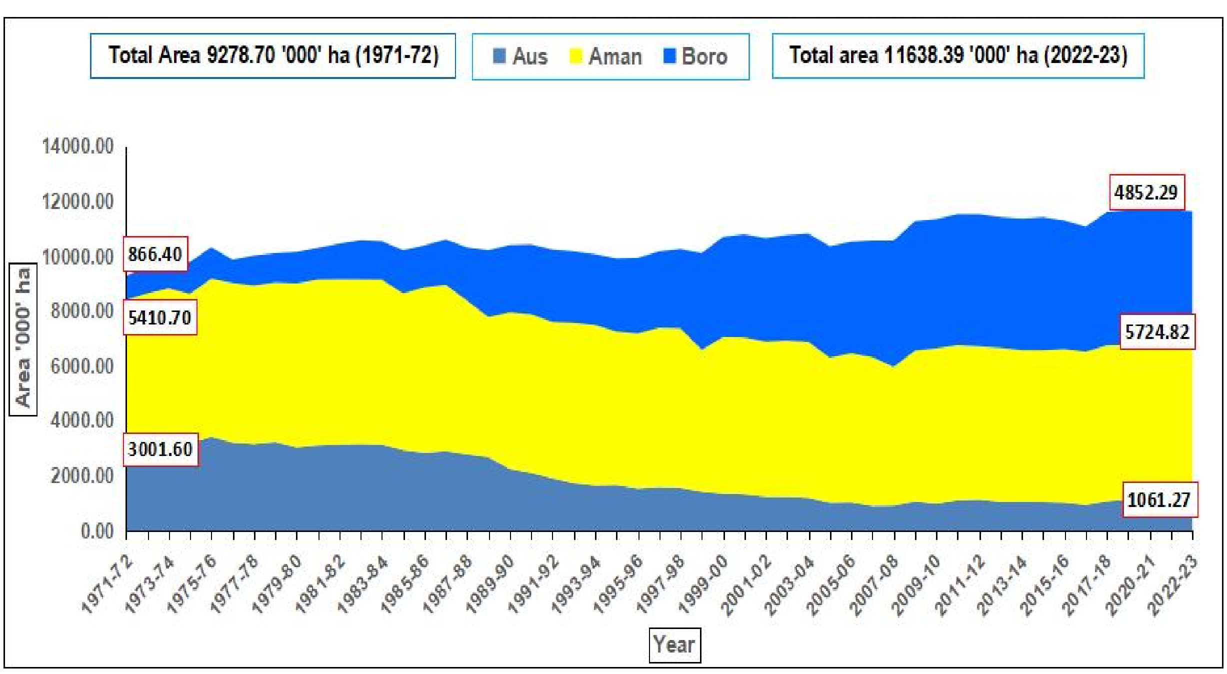
Results and Discussion

Existing databases have been updated. After necessary correction the data were analysed and the output were available in BRRI website in different form under different scenarios. Using the time series data (area and production data from 1971-72 to 2021-22) we produced rice cultivated area and production graph of Bangladesh (Graph 1 & Graph 2). Rice area increased about one and half folds but the production increased about four folds during 1971-72 to 2022-23 (Graph 3). Rice area growth rate was 3.96 in year 1972-73 but in 2021-22 is -0.95 (Table 5). Similarly, Rice production growth rate was 1.30 in year 1972-73 but in 2021-22 is 8.91 (Table 6). Besides using the rice and related database, created a Data Leadership Dashboard System. Which is uploaded in internal e-service menu of BRRI website. From which one can see and know at a glance the region and variety wise performance of BRRIs developed rice varieties.

Table 5. Rice area (000'hac.) growth rate in Bangladesh from 1971-72 to 2022-23

Year	Season			Total Area ('000' hac.)	GR (%)
	Aus	Aman	Boro		
1971-72	3001.60	5410.70	866.40	9278.70	-
1972-73	2930.00	5713.80	1002.60	9646.40	3.96
1973-74	3107.90	5718.70	1222.70	10049.30	4.18
1974-75	3179.10	5449.90	1161.20	9790.20	-2.58
1975-76	3419.90	5759.90	1147.90	10327.70	5.49
1976-77	3217.10	5806.40	854.20	9877.70	-4.36
1977-78	3161.70	5771.20	1093.70	10026.60	1.51
1978-79	3234.60	5805.10	1071.80	10111.50	0.85
1979-80	3036.30	5972.70	1148.40	10157.40	0.45
1980-81	3111.20	6035.80	1160.00	10307.00	1.47
1981-82	3145.60	6010.30	1301.70	10457.60	1.46
1982-83	3158.10	5993.00	1432.80	10583.90	1.21
1983-84	3138.70	6006.70	1401.20	10546.60	-0.35
1984-85	2937.60	5710.20	1574.40	10222.20	-3.08
1985-86	2844.90	6018.90	1533.20	10397.00	1.71
1986-87	2903.60	6052.40	1651.70	10607.70	2.03
1987-88	2788.30	5590.40	1942.60	10321.30	-2.70
1988-89	2683.46	5100.80	2438.30	10222.56	-0.96
1989-90	2255.00	5702.50	2453.60	10411.10	1.84
1990-91	2107.30	5775.30	2547.90	10430.50	0.19
1991-92	1915.90	5692.30	2634.90	10243.10	-1.80
1992-93	1735.10	5843.70	2598.90	10177.70	-0.64
1993-94	1649.40	5843.30	2580.80	10073.50	-1.02
1994-95	1663.75	5594.17	2663.54	9921.46	-1.51
1995-96	1541.85	5646.40	2753.57	9941.82	0.21
1996-97	1592.29	5802.49	2782.59	10177.37	2.37
1997-98	1565.88	5808.45	2888.56	10262.89	0.84
1998-99	1424.26	5165.50	3526.67	10116.43	-1.43
1999-00	1351.32	5704.87	3651.89	10708.08	5.85
2000-01	1325.23	5709.96	3761.84	10797.03	0.83
2001-02	1242.18	5647.22	3771.34	10660.74	-1.26
2002-03	1243.72	5682.11	3844.84	10770.67	1.03
2003-04	1202.58	5677.61	3943.50	10823.69	0.49
2004-05	1024.68	5279.92	4063.79	10368.39	-4.21
2005-06	1034.27	5429.01	4065.81	10529.09	1.55
2006-07	905.71	5415.62	4250.10	10571.43	0.40
2007-08	918.66	5048.16	4607.85	10574.67	0.03
2008-09	1065.56	5497.77	4716.31	11279.64	6.67
2009-10	984.22	5662.89	4706.60	11353.71	0.66
2010-11	1112.87	5645.64	4770.00	11528.51	1.54
2011-12	1138.00	5580.00	4810.00	11528.00	0.00
2012-13	1053.00	5610.00	4760.00	11423.00	-0.91
2013-14	1051.00	5530.20	4790.00	11371.20	-0.45
2014-15	1045.00	5530.00	4846.00	11421.00	0.44
2015-16	1025.00	5590.40	4685.10	11300.50	-1.06
2016-17	941.70	5583.30	4547.30	11072.30	-2.02
2017-18	1075.10	5679.50	4859.40	11614.00	4.89
2018-19	1145.13	5621.95	4909.85	11676.93	0.54
2019-20	1133.99	5883.80	4754.40	11772.19	0.82
2020-21	1304.99	5625.9	4872.6	11803.49	0.27
2021-22	1159.02	5719.018	4813.736	11691.77	-0.95
2022-23	1061.09	5723.47	4851.78	11636.34	-0.005

Sources: BBS and DAE

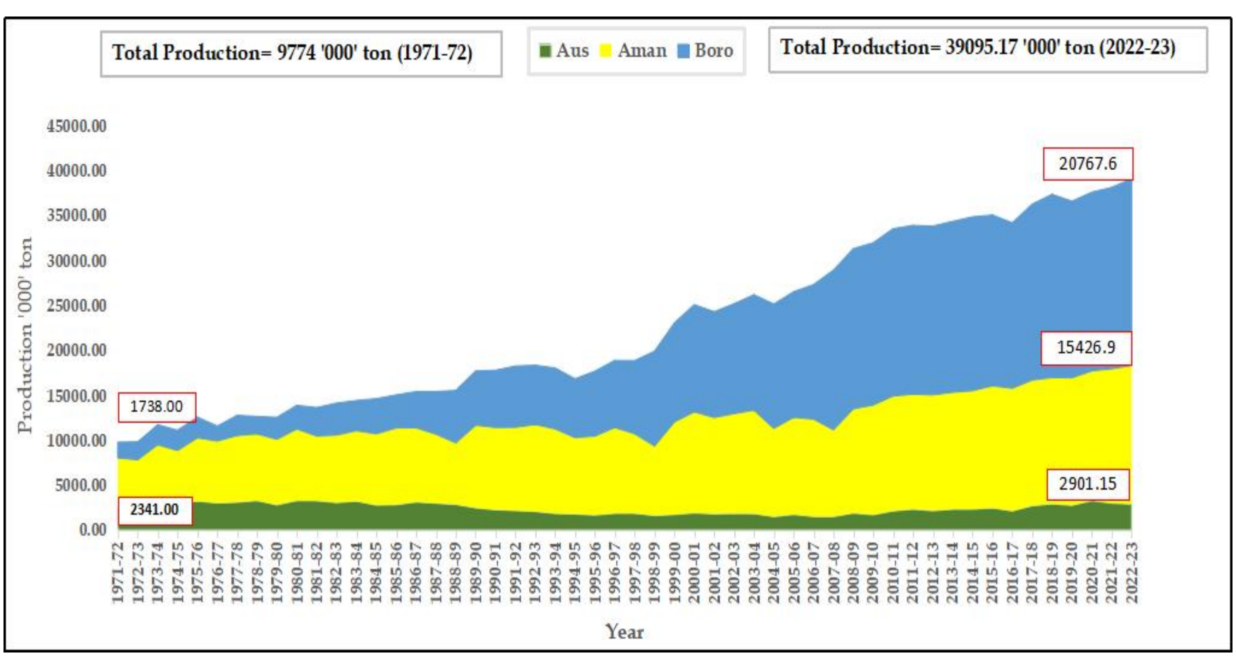


Graph 1: Cultivated area of Rice (Aus, Aman and Boro) in Bangladesh from 1971-72 to 2022-23

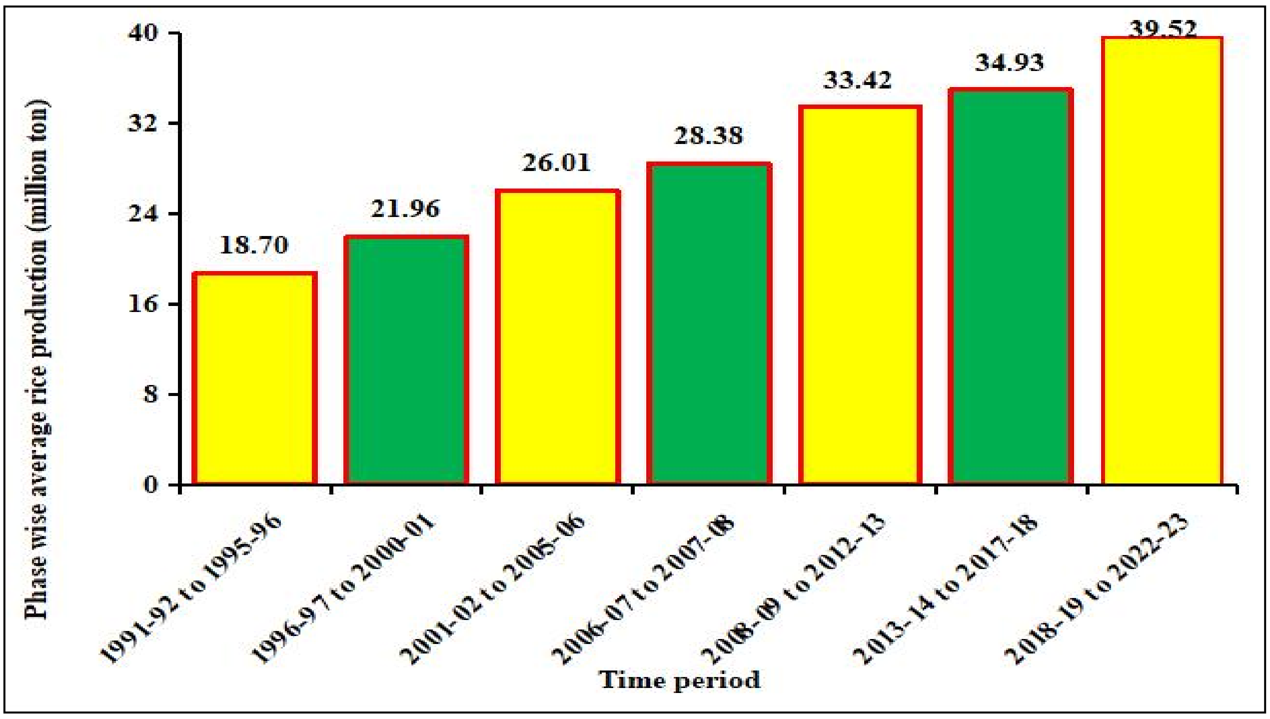
Table 6. Rice production (000'm.ton) growth rate in Bangladesh from 1971-72 to 2022-23

Year	Season			Total Production ('000' mton.)	GR (%)
	Aus	Aman	Boro		
1971-72	2341.00	5695.00	1738.00	9774.00	-
1972-73	2243.00	5587.00	2071.00	9901.00	1.30
1973-74	2801.00	6699.00	2220.00	11720.00	18.37
1974-75	2859.00	6000.00	2250.00	11109.00	-5.21
1975-76	3229.00	7045.00	2286.00	12560.00	13.06
1976-77	3014.00	6905.00	1650.00	11569.00	-7.89
1977-78	3103.00	7422.00	2239.00	12764.00	10.33
1978-79	3287.00	7429.00	1929.00	12645.00	-0.93
1979-80	2809.00	7303.00	2427.00	12539.00	-0.84
1980-81	3289.00	7964.00	2630.00	13883.00	10.72
1981-82	3270.00	7209.00	3152.00	13631.00	-1.82
1982-83	3065.00	7516.00	3548.00	14129.00	3.65
1983-84	3222.00	7843.00	3350.00	14415.00	2.02
1984-85	2783.00	7930.00	3909.00	14622.00	1.44
1985-86	2828.00	8542.00	3671.00	15041.00	2.87
1986-87	3130.00	8267.00	4010.00	15407.00	2.43
1987-88	2993.00	7690.00	4731.00	15414.00	0.05
1988-89	2856.00	6857.00	5831.00	15544.00	0.84
1989-90	2475.00	9202.00	6033.00	17710.00	13.93
1990-91	2261.00	9167.00	6357.00	17785.00	0.42
1991-92	2179.00	9269.00	6807.00	18255.00	2.64
1992-93	2075.00	9680.00	6586.00	18341.00	0.47
1993-94	1850.20	9419.20	6772.20	18041.60	-1.63
1994-95	1790.70	8504.00	6538.70	16833.40	-6.70
1995-96	1676.00	8790.00	7220.60	17686.60	5.07
1996-97	1870.00	9551.00	7460.00	18881.00	6.75
1997-98	1874.60	8849.80	8137.30	18861.70	-0.10
1998-99	1616.90	7735.80	10551.90	19904.60	5.53
1999-00	1734.00	10306.00	11027.00	23067.00	15.89
2000-01	1916.00	11249.00	11920.50	25085.50	8.75
2001-02	1808.00	10726.00	11766.00	24300.00	-3.13
2002-03	1850.70	11118.40	12222.20	25191.30	3.67
2003-04	1831.80	11520.50	12837.10	26189.40	3.96
2004-05	1500.00	9819.00	13837.10	25156.10	-3.95
2005-06	1745.00	10810.00	13975.30	26530.30	5.46
2006-07	1512.00	10841.00	14965.00	27318.00	2.97
2007-08	1507.00	9662.00	17762.00	28931.00	5.90
2008-09	1895.00	11613.00	17809.00	31317.00	8.25
2009-10	1709.00	12207.00	18059.00	31975.00	2.10
2010-11	2132.82	12791.50	18616.00	33540.32	4.90
2011-12	2333.00	12798.00	18783.00	33914.00	1.11
2012-13	2158.00	12897.00	18778.00	33833.00	-0.24
2013-14	2326.00	13023.30	19007.00	34356.30	1.55
2014-15	2328.00	13190.20	19343.00	34861.20	1.47
2015-16	2468.00	13591.40	19001.10	35060.50	0.57
2016-17	2133.60	13656.00	18411.90	34201.50	-2.45
2017-18	2709.70	13993.80	19575.80	36279.30	6.08
2018-19	2920.20	14054.9	20388.5	37363.60	2.99
2019-20	3011.87	15502.09	20181.4	38695.33	3.56
2020-21	3284.70	14437.80	20885.30	38607.80	-0.23
2021-22	3000.00	14958.00	20186.00	38144.00	-1.20
2022-23	2901.00	15426.00	20768.00	39095.00	0.030

Sources: BBS and DAE



Graph 2: Rice Production (Aus, Aman and Boro) in Bangladesh from 1971-72 to 2022-23



Graph 3: Phase wise increment of rice production in Bangladesh (1991-92 to 2022-23)

Conclusion

Rice area increased about one and half folds but the production increased about four folds during 1971-72 to 2022-23. Although the growth rate of rice area was 3.96 in year 1972-73 but in 2022-23 is -0.005. Similarly, growth rate of rice production was 1.30 in year 1972-73 but in 2022-23 is 0.03. Moreover, rice and related data have been updating regularly and the collected data are being available in BRRI website. Also, being producing different types of graphs, trend and climatic map of Bangladesh by using the database as per requirement of BRRI authority and BRRI scientists.

Project 4: Utilization of geographical information system (GIS) in rice research

Activity 4.1: Suitability (Edaphic) Mapping of BRRI dhan101-104

(In collaboration with Plant Breeding Div., Soil Science Div. and ARD)

- Md. Abdullah Aziz, Dr. Biswajit Karmaker, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun

Introduction

Bangladesh agriculture involves food production for 163.65 million people from merely 8.75 million hectares of agricultural land (Salam *et al.,* 2014). More food will be required in future because of increasing population as well as decreasing resources (e.g., land, labour, soil health and water) and increasing climate vulnerability (e.g., drought, salinity, flood, heat and cold) appeared as the great challenges to keep the pace of food production in the background of increasing population. Sufficient rice production is the key to ensure food security in Bangladesh. In fact, Rice security is synonymous to "Food security" in Bangladesh as in many other rice growing countries (Brolley, 2015). We have very limited amount of land resource, moreover 0.4% rice land is reducing every year (The daily Prothom-Alo, 2015). Thus, we need to best use of limited land resource. Our land is not homogenous all over the Bangladesh. Various physical and chemical properties of soil vary spatially, on the other hand various rice varieties are suitable for some specific physical and chemical properties. As we need to high production with limited land, so it will be very helpful if we have variety wise suitability map based on soil properties. BRRI dhan101 to BRRI dhan104 varieties are prospective varieties. So, these varieties land suitability maps are very important.

Objectives

1. To construct edaphic suitability maps for newly released BRRI varieties.
2. To find out variety wise suitable area for production.

Methodology

Soil physical properties namely, land type, top soil texture, relief, soil consistency, soil moisture, soil permeability, soil reaction soil salinity, drainage and slope were considered to determine area suitable for growing respective rice varieties. The suitability scale 1 to 3 was assigned to each soil characteristic in relation to respective rice varieties cultivation.

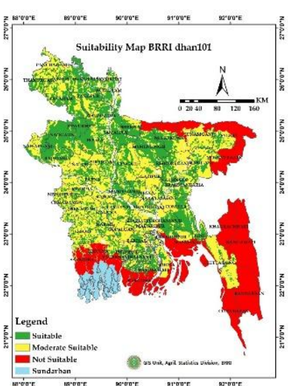
- 1- for the suitable,
- 2- for moderately
- 3- for not suitable.

Suitable areas for respective rice varieties cultivation in Bangladesh were determined by two steps: step 1, Input vector themes of land type and other soil physical properties were converted into grid themes for analysis in the Model Builder environment using Arc GIS 10.3 Spatial Analyst Module. Step 2, Then each input grid was weighted by the relative influence for suitability assessment. The relative influences were the relative weights in precent assigned to grid themes of soil parameters. These weights were the values of "Precent Influence Field" in the weighted overlay table of the Model Builder.

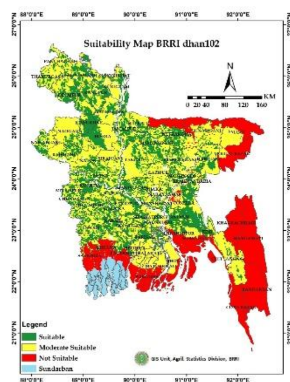
Results and Discussion

Boro Season: Suitable area for BRRI dhan101, BRRI dhan102 and BRRI dhan104 are more or less same. These varieties are mainly suitable in north-west part of Bangladesh. BRRI dhan102 is also suitable in all over the western part of Bangladesh and BRRI dhan104 some part of central southern area of Bangladesh. Map-1, 2, 3 and 4 are showing suitability maps of BRRI dhan101, BRRI dhan102 and BRRI dhan104 respectively.

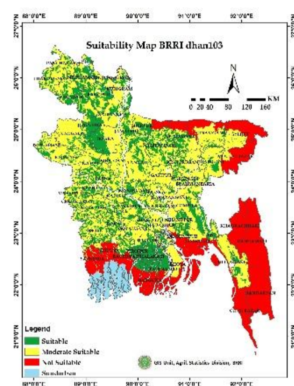
Aman Season: BRRI dhan103 is appropriate for north-west and some part of central southern area. Map 3 shows the suitability map of BRRI dhan103.



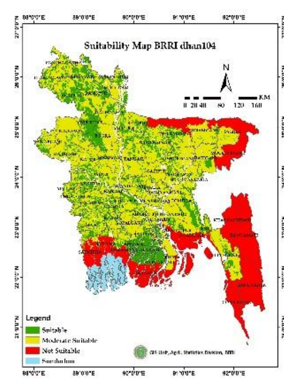
Map 1: Suitability map of BRRI dhan101



Map 2: Suitability map of BRRI dhan102



Map 3: Suitability map of BRRI dhan103



Map 4: Suitability map of BRRI dhan104

Conclusion

For Boro season, BRRI dhan101 and BRRI dhan104 are suitable mainly in north-western part of Bangladesh but BRRI dhan102 is also suitable in all over the western part of Bangladesh.For T.Aman season, BRRI dhan103 are suitable mainly in north-western part of Bangladesh

Activity 5.2: Climatic Mapping of Temperature (Maximum & Minimum) and Rainfall

- Md. Abdullah Aziz, Md. Asadullah, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun.

Introduction

Bangladesh is an agro-based country. Agriculture of Bangladesh still depends on mercy on climate**.** Climatic factors such as temperature, rainfall, atmospheric carbon dioxide and solar radiation etc. are closely linked with agriculture production. Therefore, rice production would be major concern in recent years due to changing climatic conditions. Because there is a significant amount of rice yield may hamper for only fluctuations of those climatic parameters (Basak, 2010). Thus, climatic factors mapping would be great tool for climatic factors analysis and assist to increase crop production.

Objectives

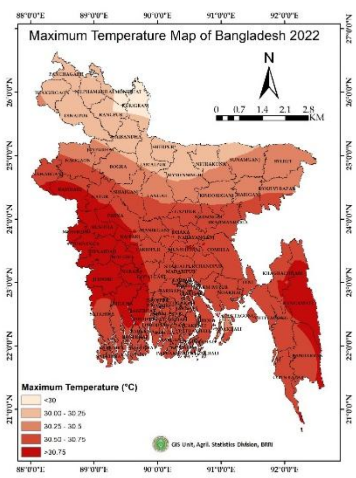
1. To determine expected maximum and minimum temperature and rainfall in different region in Bangladesh.
2. To determine areas of critical maximum and minimum temperature and rainfall map of Bangladesh during the period and
3. Year wise comparison of various climatic factors maps and determines their change directions.

Methodology

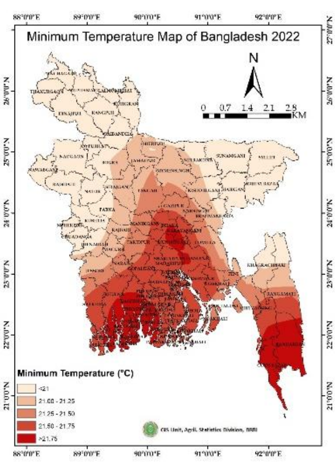
Data on daily maximum and minimum temperature and rainfall of 42 weather stations of BMD for the year of 2021 was used for the study. Year and stations wise maximum value of maximum temperature and minimum value of minimum temperature and total rainfall were determined. Then by using Geo-statistical tools of Arc GIS10.8 software maps were prepared. From the maps scenario of climatic factors were described.

Results and Discussion

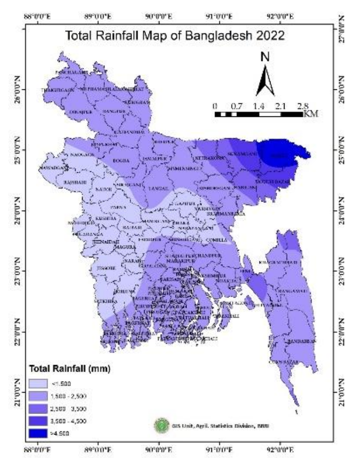
In 2022, maximum temperature was high in central western part of Bangladesh and north-western regions. Map 5 shows the maximum temperature map of Bangladesh for 2022. Minimum temperature was lower in north-western and high was in eastern region. Map 6 shows the minimum temperature map of Bangladesh for 2022. Total rainfall was the highest in north-east corner, lowest were central and western parts of Bangladesh. Map 7 shows the total rainfall map of Bangladesh for 2022.



Map 5: Max.temp. of Bangladesh in 2022



Map 6: Min.temp. of Bangladesh in 2022



Map 7: Total rainfall of Bangladesh in 2022

Conclusion

More or less throughout the year eastern side of Bangladesh was high rainfall and low temperature area and western side was low rainfall and high temperature area. Spatial distribution of minimum temperature and total rainfall were more or less same.

Activity 5.3: Season wise rice area mapping of Bangladesh

(In collaboration with IWM and all R/S)

-Md. Abdullah Aziz, Setara Yesmin, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun.

Introduction

Bangladesh is an agro-based country and rice is the main agricultural product. Rice contributes more than 80 percent to the total food supply (Bhuiyan et al, 2002). Now a days, remote sensing and GIS are considering as powerful tools for crop mapping, monitoring and yield forecasting. These tools are very much reliable, moreover, it is time, labor and cost effective. Identification of crop types and mapping are the first steps of satellite remote sensing-based crop monitoring and yield forecasting system (Shewalka et al., 2014). So far in Bangladesh limited research has been done for satellite remote sensing-based rice crop identification and mapping. Thus, in Bangladesh context rice mapping using Satellite remote sensing is very important. For a good planning for rice pricing, export- import decision etc. we need season wise rice crop area estimate through mapping, monitoring and yield forecasting.

Objectives

- To construct season wise rice area map of Bangladesh.
- To estimate season wise rice area of Bangladesh

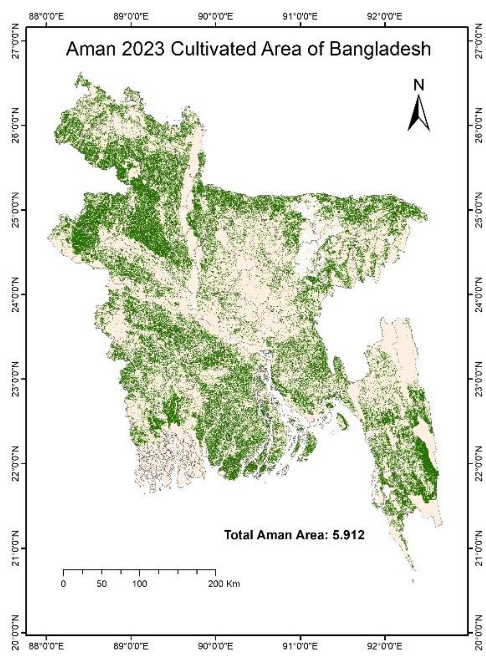
Methodology

Remote sensing and GIS are considering as powerful tools for crop mapping. Satellite Images were collected from MODIS data portal of NASA. Time series and level 03 product image of Normalized Difference of Vegetation Index (NDVI), Effective vegetation index (EVI) and Land Surface Water Index (LSWI) were collected according to the respective rice growing season. Whenever rice crop is initial stage i.e., transplanting time its vegetation index is very low and peak vegetative stage i.e., PI or booting stage its vegetation index is very high and in ripening or harvest time its vegetation index become again low. This algorithm was applied in agriculture area of Bangladesh and threshold value developed by ground truth data collected through GPS reading of various rice field all over the Bangladesh. Then season wise rice maps were prepared. Then district wise rice cultivated area were calculated.

Results and Discussion

Aman area 2023

The total area of rice grown in Aman in 2023 was about 5.91 Mha. The districts with the highest of land under cultivation were Naogaon (about 272568 ha) and Dinajpur (approximately 264393 ha), whereas the districts with the lowest of land under cultivation were Munshiganj and Narayangaj respectively, with areas of about 15400 ha and 5568 ha (Map 8 and Table 7).



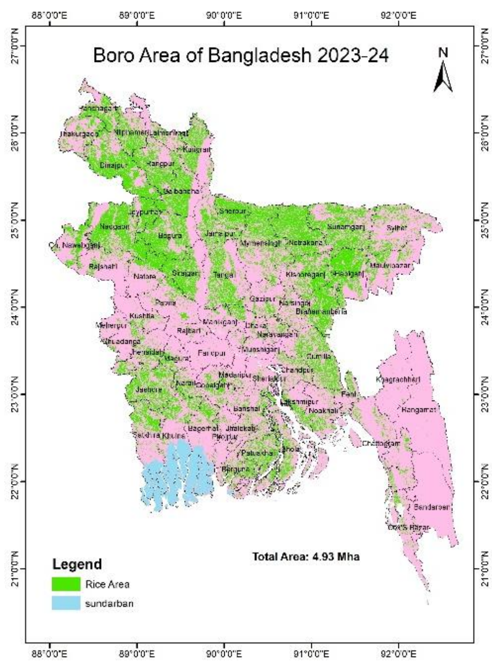
Map 8: Aman 2023 Cultivated Area Map of Bangladesh

Table 7: District wise Aman 2023 Area Bangladesh

District	Area_ha	District	Area_ha	District	Area_ha	District	Area_ha
Barishal	122675	Gazipur	15437.5	Kushtia	73737.5	Sirajganj	103062.5
Jhalokati	48175	Gopalganj	71618.75	Magura	63031.25	Dinajpur	264393.75
Pirojpur	83656.25	Kishoreganj	48237.5	Meherpur	27281.25	Gaibandha	123643.75
Bandarban	51375.5	Madaripur	63050	Narail	41806.25	Kurigram	76887.5
Brahamanbaria	80593.75	Manikganj	27350	Satkhira	87956.25	Lalmonirhat	77200
Chandpur	64418.75	Munshiganj	15400	Jamalpur	113612.5	Nilphamari	45218.75
Chattogram	177550	Narayanganj	5568.75	Mymensingh	185793.75	Panchagarh	62493.75
Cumilla	136912.5	Narsingdi	21193.75	Netrakona	158856.25	Rangpur	183575
Cox'S Bazar	70681.25	Rajbari	43150	Sherpur	89181.25	Thakurgaon	120700
Feni	45793.75	Shariatpur	31593.75	Bogura	231043.75	Habiganj	94837.5
Khagrachhari	47187.5	Tangail	91256.25	Joypurhat	78406.25	Maulvibazar	70906.25
Lakshmipur	49662.5	Bagerhat	88037.5	Naogaon	272568.75	Sunamganj	135737.5
Noakhali	119987.5	Chuadanga	21062.5	Natore	95881.25	Sylhet	179625
Rangamati	152906.25	Jashore	128968.75	Ch. Nawabganj	89962.5	Barguna	94381.25
Dhaka	23681.25	Jhenaidah	101900	Pabna	55431.25	Patuakhali	162468.75
Faridpur	93306.25	Khulna	117931.25	Rajshahi	120875	Bhola	75093.75
Total							**5912581.25**

Boro area 2023-24

The total area of rice grown in Boro in 2023-24 was about 4.93 Mha. The districts with the highest of land under cultivation were Naogaon (approximately 259987 ha), Dinajpur (about 251887 ha) and Netrokona (approximately 238862 ha), whereas the districts with the lowest of land under cultivation were Rangamati and Bandarban respectively, with areas of about 960 ha and 550 ha (Map 9 and Table 8).



Map 9: Boro 2023-24 Area Map of Bangladesh

Table 8: District wise Boro 2023-24 Area Bangladesh

DISTNAME	Area_ha	DISTNAME	Area_ha	DISTNAME	Area_ha	DISTNAME	Area_ha
Barishal	63806	Gazipur	40463	Kushtia	20669	Sirajganj	143506
Jhalokati	13969	Gopalganj	46850	Magura	28531	Dinajpur	251888
Pirojpur	13400	Kishoreganj	146375	Meherpur	4638	Gaibandha	145631
Bandarban	550	Madaripur	15350	Narail	36244	Kurigram	105775
Brahamanbaria	133469	Manikganj	13375	Satkhira	81575	Lalmonirhat	32113
Chandpur	42150	Munshiganj	5800	Jamalpur	95288	Nilphamari	90850
Chattogram	52275	Narayanganj	16938	Mymensingh	223281	Panchagarh	77481
Cumilla	155263	Narsingdi	32913	Netrakona	238863	Rangpur	145125
Cox'S Bazar	26263	Rajbari	6906	Sherpur	110038	Thakurgaon	61813
Feni	24919	Shariatpur	12619	Bogura	194988	Habiganj	182669
Khagrachhari	2819	Tangail	153356	Joypurhat	75313	Maulvibazar	57363
Lakshmipur	40038	Bagerhat	43419	Naogaon	259988	Sunamganj	225463
Noakhali	49725	Chuadanga	17369	Natore	68169	Sylhet	96125
Rangamati	963	Jashore	157406	Ch. Nawabganj	62219	Barguna	49675
Dhaka	42431	Jhenaidah	63844	Pabna	47694	Patuakhali	106363
Faridpur	3475	Khulna	67400	Rajshahi	41144	Bhola	63813
Total							**4930181**

Conclusion

About 5.91 Mha of rice were cultivated in Bangladesh during 2023 Aman season and highest Aman production district was Naogaon. In the year 2022 total Aman area was 5.82 Mha. Thus, total Aman area has been increased a little bit in the year 2023. In 2023-24 total Boro area was about 4.93 Mha in Bangladesh. Naogaon district produced the highest Boro production in 2023-24.

Activity 4.4: Projected Climatic Factors (2050) Maps of Bangladesh

- Md. Abdullah Aziz, Niaz Md. Farhat Rahman, Rokib Ahmed, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun.

Introduction

Bangladesh is still significantly reliant on agriculture, and agriculture has a significant relation with climate. Bangladesh's food production is threatened by climate change. Predicting future climate changes is extremely crucial for smart agricultural planning and adapting to climate change. As the climate is changing, we need to predict future climatic conditions to cope with climate change and keep the food security of Bangladesh. This is the goal of the government of Bangladesh as well as set in the sustainable development goals (SDGs) by the United Nations to ensure food security by establishing climate resilient crop production (Rahman et al., 2021). The future prediction of precipitation would help to take necessary policies for the development of future climate resilient agricultural technologies.

Objectives

1. To construct projected climatic factors maps of Bangladesh for 2050
2. To determined projected climatic factors value district/division wise of Bangladesh for 2050.
3. To deliver an idea about future climate to researchers and planners

Methodology

Step-1: Data Collection

In this study, we used the most recurrently used source of freely available, high resolution, downscaled, bias-corrected, and long-term climate raster dataset with global coverage, WORLDCLIM 1.4, for past (1970-2000) and future (2040-2060 or 2050), its updated version 2.1 (Fick and Hijmans 2017) present (2010-2018) for precipitation. All the data are in raster with a high spatial resolution of 2.5 arc minutes.

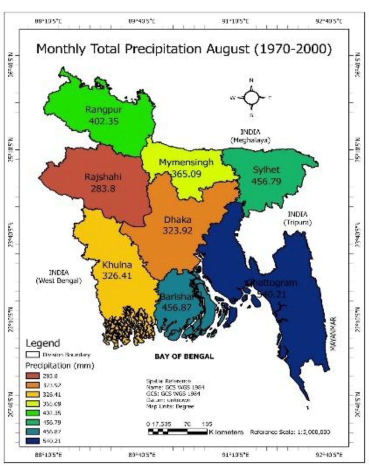
Step-2: Compilation and Processing of Climate Data

Cell statistics function from the GIS software (ArcGIS 10.3 version)

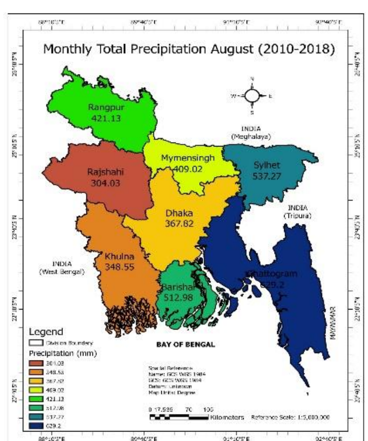
Step-3: Preparation of Precipitation Projection Map

Whole country and division-wise precipitation map (Map 10 to 15) for the past (1970-2000), present (2000-2018) and future (2040-2060 or 2050) prepare using Arc GIS software.

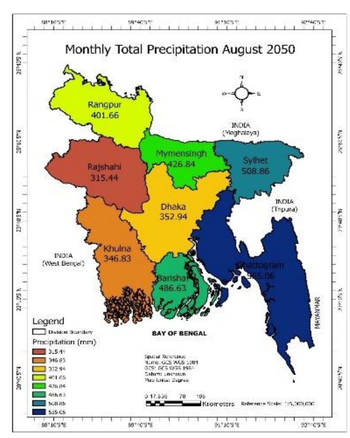
Results and Discussion



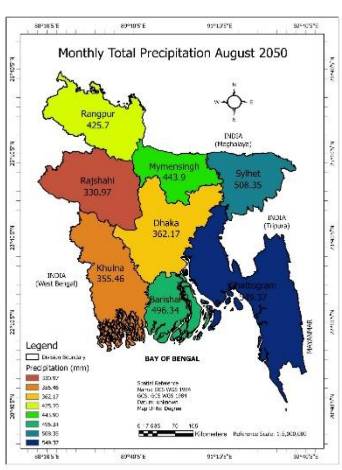
Map 10: August month average of total precipitation from 1970-2000



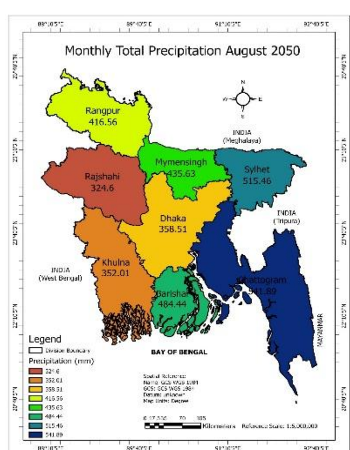
Map 11: August month average of total precipitation from 2010-2018



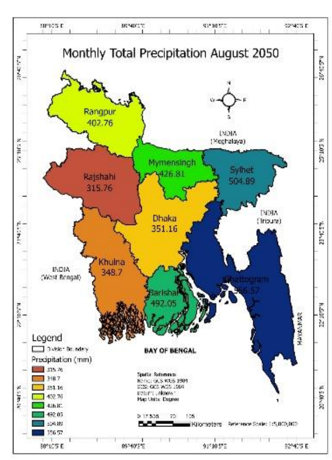
Map 12: August month average of total precipitation for the year 2050 according to RCP 2.6



Map 13: August month average of total precipitation for the year 2050 according to RCP 4.5



Map 14: August month average of total precipitation for the year 2050 according to RCP 6.0



Map 15: July month average of total precipitation for the year 2050 according to RCP 8.5

Map 10: North-east and south part of the country was under moderate precipitation and rest of the country was under lower precipitation. A division-wise analyses shows that in August month average total precipitation was highest in Chattogram division (540.21 mm) and lowest precipitated division was Rajshahi where average precipitation was 283.8 mm

Map11: Describing division wise average total precipitation of August month during 2010-2018 where the Chattogram division was the highest precipitation (629.2 mm) and Rajshahi was the lowest (304.03 mm) precipitated division.

Map12: The division wise analyses shows that average precipitation in August month was highest in Chattogram division (555.06 mm) and Rajshahi was lowest precipitated division with an average of 315.44 mm

Map13: Shows that the highest precipitation was experienced in Chattogram division (549.37 mm) and the lowest precipitation division will be Rajshahi (330.97 mm).

Map14: Representing that the highest precipitation division was Chattogram (541.89 mm) and the lowest precipitation division will be Rajshahi (324.6 mm).

Map15: The forecasted precipitation results are not differing much with the RCP 2.6, 4.5, and 6.0 models. The highest precipitation division were again Chattogram (566.57 mm) and the lowest precipitation division will be Rajshahi as 315.76 mm

Summary of August month average total precipitation of 1970 to 2000, 2010 to 2018 and forecasted 2050 showing in the table 10

Table 09: Summary of August month average total precipitation of 1970 to 2000, 2010 to 2018 and forecasted 2050 (By RCP model 2.6, 4.5, 6.0 and 8.5)

Division	Average Precipitation (mm)1970 to 2000	Average Precipitation(mm) 2010 to 2018	Precipitation(mm)2050 (RCP 2.6)	Precipitation(mm)2050 (RCP 4.5)	Precipitation (mm) 2050(RCP 6.0)	Precipitation (mm) 2050(RCP 8.5)	Average of Precipitation (mm) 2050(RCP 2.6, 4.5, 6.0 and 8.5)	Average of Precipitation (mm) 2050 to 2010-2018
Barishal	456.87	512.98	486.63	496.34	484.44	492.05	489.86	-23.12
Chattogram	540.21	629.2	555.06	549.37	541.89	556.57	550.72	-78.48
Dhaka	323.92	367.82	352.94	362.17	358.51	351.16	356.19	-11.63
Khulna	326.41	348.55	346.83	355.46	352.01	348.7	350.75	2.20
Mymensingh	365.09	409.02	426.84	443.9	435.63	426.81	433.30	24.28
Rajshahi	283.8	304.03	315.44	330.97	324.6	315.76	321.69	17.66
Rangpur	402.35	421.13	401.66	425.7	416.56	402.76	411.67	-9.46
Sylhet	456.79	537.27	508.86	508.35	515.46	504.89	509.39	-27.88

Conclusion

All divisions of Bangladesh, average total precipitation (average by RCP 2.6, 4.5, 6.0, and 8.5 models) of August month in 2050 will be decreased in comparison to average total precipitation of 2010-2018 period, only exceptions are Khulna, Rajshahi, Mymensingh divisions.

Activity 5.5: Suitability Mapping of Various Cropping Pattern

Md. Abdullah Aziz, Rokib Ahmed, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun.

Introduction

Cropping pattern is important in agricultural system. Various physical and chemical properties of soil vary spatially, on the other hand various cropping pattern are suitable for some specific physical condition. As we need to high production with limited land, so it will be very helpful if we have cropping pattern wise suitability map based on soil properties.

Objectives

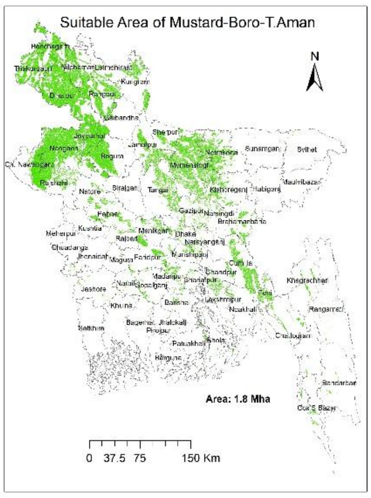
1. To construct suitability maps for major cropping pattern of Bangladesh.
2. To find out cropping pattern wise suitable area for production.

Methodology

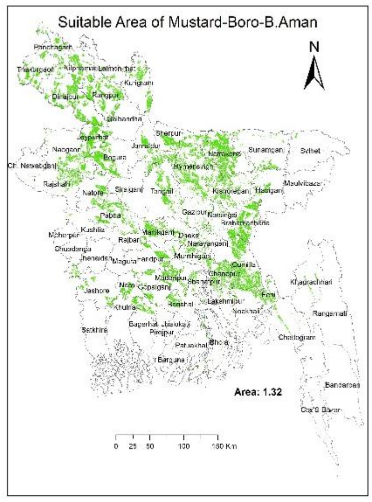
Four (04) soil properties digital maps were collected from Bangladesh Agricultural Research Council (BARC). Like, 1. Land type 2. Soil Texture 3. Soil salinity 4. Slope. Suitable classes for four (04) soil properties of respective cropping patterns were selected. All selected area were then intersected to extract out suitable area for cultivation of respected cropping pattern. Suitable area of all cropping patterns was calculated in hectors. The whole process was carried out by Arc GIS environment.

Results and Discussion

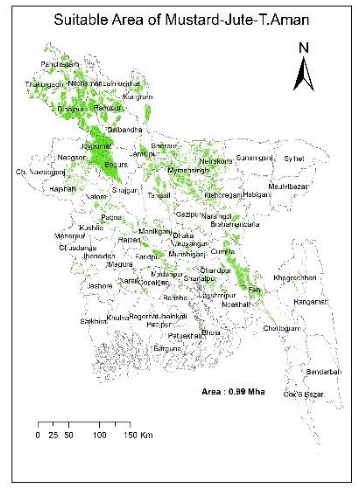
Mustard-Fallow-T.Aman cropping pattern is suitable in north-west part of Bangladesh (Map 16) and total suitable area is 1.8Mha. Mustard-Boro-B.Aman cropping pattern cover total suitable area 1.32 Mha and these suitable area in central side of Bangladesh (Map 17). Mustard-Jute-T.Aman is suitable in north-west and central northern sides of Bangladesh (Map 18) and total suitable area is 0.99 Mha.



Map 16: Suitability Map of Mustard-Boro-T.Aman



Map 17: Suitability Map of Mustard-Boro-B.Aman



Map 18: Suitability Map of Mustard-Jute-T.Aman

Conclusion

Production will be increased if we cultivate the specific cropping pattern in their specific suitable area**.** Mustard-Fallow-T.Aman cropping pattern is suitable in north-west part of Bangladesh and total suitable area is 1.8Mha. Mustard-Boro-B.Aman cropping pattern cover total suitable area 1.32 Mha and these suitable area in central side of Bangladesh. Mustard-Jute-T.Aman is suitable in north-west and central northern sides of Bangladesh and total suitable area is 0.99 Mha. These suitability maps are very much useful for technology dissemination and adaptation.

Activity 5.6: Rice Yield Estimating Using Unmanned Aerial Vehicles (UAVs) Data

(A collaboration with BSMRAU)

Md. Abdullah Aziz, Md. Ismail Hossain, Hasan Muhammad Abdullah

Introduction

Traditional, direct measurements of crop yield is time consuming, laborious and costly and before harvesting it is never possible. Moreover, a range of crop-cuts and sample techniques may lead to inconsistent results. Measurements from optical instruments, model simulations, and remote sensing retrievals are used to estimate indirect yield and LAI (Ji Z et al., 2021, Tillack, A. et al. 2014, Yan, G.J et al 2016). Using remote sensing and UAV data to estimate the crop yield is less expensive and time-consuming than alternative methods, and it is ideal for extensive and ongoing vegetation monitoring with the least amount of effort.

Objectives:

1. To develop a mathematical model between rice yield and UAV images.
2. To develop a rice yield estimation model that takes less time, labour, and cost.

Methodology

A UAV were operated, to capture image over BRRI stability analysis plot various time in a rice season synchronizing the growth stage of the rice. Various vegetation indices like, NDVI, SAVI etc. were produced. We conducted some machine learning model like, Random-forest, Support Vector and Linear-regression and ensemble the models in google colab platform using python script, between NDVI and observed yield. Here, 80% data used as training sample and rest of data used for model validation. Finally, Validated the model.

Results and Discussion

Among the Random-forest, Support Vector, Linear-regression and ensemble model mean square error (MSE) are 0.609, 0.690, 0.617 and 0.606 respectively, thus we have chosen ensemble model for yield prediction (Fig. 23).

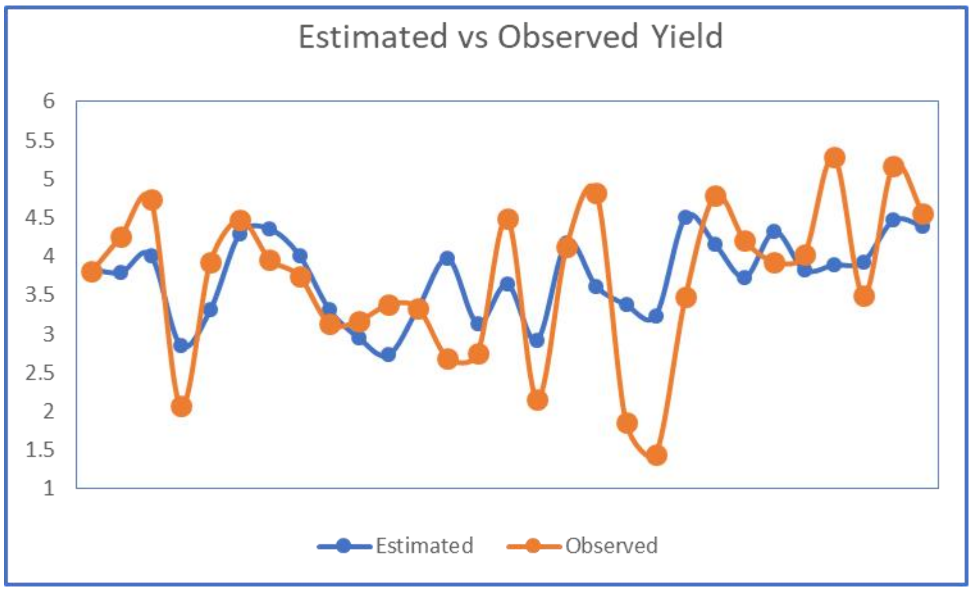


Fig. 23: Observed yield vs estimated yield by ensemble model

Conclusion:
Though among the random-forest, support vector, linear-regression and ensemble model we found ensemble model is the best fitted model for yield prediction but still model is not good fitted model. So, the study should continue to improve the model.

Activity 5.7: Delineation of Rice Area changes in Costal Area of Bangladesh Using Remote Sensing Data and Machine Learning Approach

(In collaboration research with BRRI R/S Barishal)

- Md. Abdullah Aziz, Rokib Ahmed, Md. Ismail Hossain, Md. Abdul Qayum and Md. Abdullah Al Mamun.

Introduction
The Rice Area of Bangladesh is not the same over time. Various environmental and socio-economic causes of the rice area vary over time. Moreover, recently governments have many interventions to increase the rice area, especially in coastal regions like the Barishal and Khulna divisions. Thus, it is important to know the effect of their program through delineating the rice area changes over time.

Objectives
- Delineate the rice area changes over time
- To quantify the types of land cover that migrated into and out of the rice-growing region.
- To delineate the prospect of Boro rice expansion.

Methodology

Study Area
Amtali Upazila is in the southeastern part of Barguna District of Bangladesh. It is located between longitudes 90°00' and 90°23' east and latitudes 21°51' and 22°18' north (Banglapedia, 2023). There are 212 square kilometers of water in its 695 square kilometers total area (Amtali Upazila Administration, 2023). According to Banglapedia (2023), the upazila is bordered to the north by Patuakhali Sadar Upazila, to the south by the Bay of Bengal, to the east by Galachipa and Kalapara Upazilas, and to the west by Barguna Sadar and Mirzaganj Upazilas (Fig. 24).
Amtali Upazila enjoys year-round high temperatures and copious amounts of rainfall due to its tropical monsoon environment. The average annual temperature is 27°C, with May to June being the hottest months at 32°C and December to January being the lowest at 20°C. With the monsoon season (June to September) accounting for the majority of the precipitation, the average annual rainfall is 2,500 mm. At 70 percent on average, the humidity stays high all year round (Bangladesh Meteorological Department, 2023).

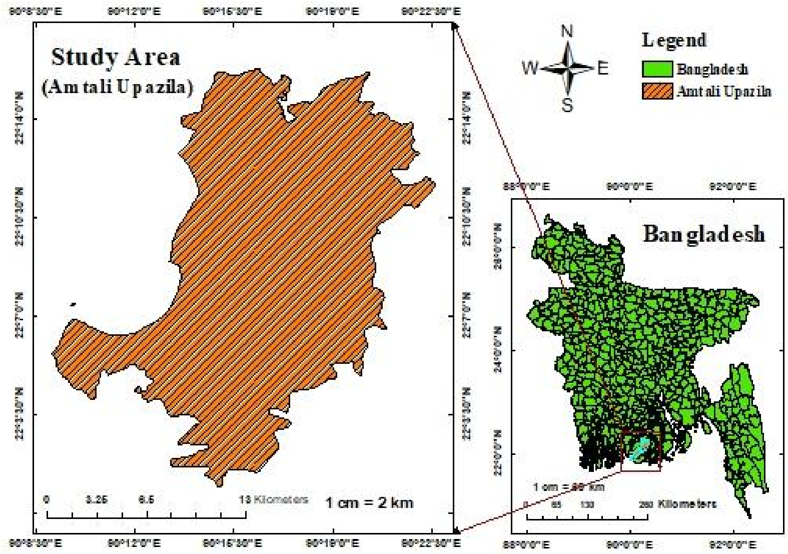


Fig. 24: Study Area Map

Data:
For this study, Sentinel 2A, 10m spatial resolution satellite imagery data was utilized to assess the land use land cover (LULC) changes during the Boro season in Amtali upazila of the Barguna district. In Bangladesh boro rice is cultivated from December to May (Rahman et al., 2013; Gumma et al., 2014; Faisal et al., 2019; Mainuddin et al., 2021). In March boro rice comes in peak vegetative stages i.e., maximum tillering/booting stages (Faisal et al., 2019, Gumma et al., 2014; Singha et al., 2019).

Image Pre-processing and Classification
The collected images were stacked together to form an RGB image, which was then used to produce a preliminary land use land cover map (LULC) for each year (2019 and 2022). To achieve more accurate and detailed classification, the images were analyzed and training data were produced based on colour, texture, tone, and structure, which allowed for the identification of different land cover types (Bianconi et al., 2021; Navarro et al 2019; Hiremath and Bhusnurmath 2014). Then Maximum Likelihood supervised image classification was used to prepare final land use land cover maps.

Methodological framework

Collect NIR, Red, Green band images for March 2019 and 2023 of the study area

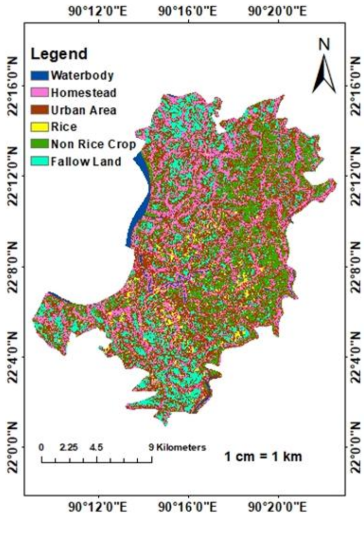
↓

Produce LULC maps for 2019 and 2023

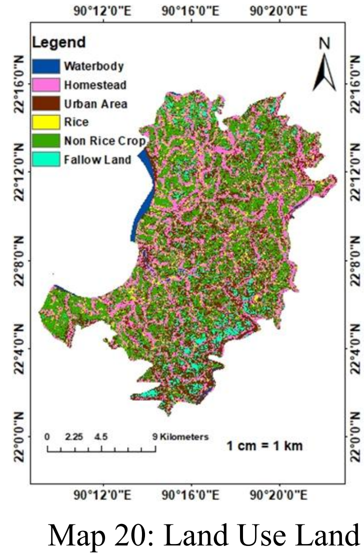
↓

Perform Change Detection Analysis

Results:
From land use land cover map of 2019 and 2023 (Map 19 and 120) the land cover changes can be detected precisely. The Rice area has increased sufficiently in 2023**.**



Map 19: Land Use Land Cover of Babuganj Upazila 2019



Map 20: Land Use Land Cover of Babuganj Upazila 2022

From the LULC maps, the extracted data are shown in the table (Table 10) below:

Table 10: Land Use Land Cover Change of Amtali Upazila from 2019 to 2023

SL No.	Change	Area(ha)_2019	Area(ha)_2023	Area_Change	Area_Change(%)
1	Waterbody	755.258	554.764	-200.494	-26.546
2	Homestead	7301.580	8926.299	1624.718	22.251
3	Urban Area	12800.137	7953.843	-4846.293	-37.861
4	Rice	834.324	1434.832	600.508	71.975
5	Non-Rice Crop	5223.376	11163.666	5940.290	113.725
6	Fallow Land	4906.149	1787.461	-3118.687	-63.566
	Total	**31820.826**	**31820.868**		

The biggest change was in the area of non-rice crops, which increased by 113.72 percent. The second biggest change was in the area of rice, which increased by 71.98 percent. This is likely due to many factors, including the increasing demand for food, the expansion of irrigation systems, and the development of new agricultural technologies. The area of fallow land decreased by 63.57 percent between the years 2019 and 2023. This is likely due to the conversion of fallow land to other uses, such as agriculture, and infrastructure development. The area of homesteads increased by 22.25 percent between the years 2019 and 2023. This is likely due to the population growth and the increasing demand for housing. The area of urban areas decreased by 37.86 percent between 2019 and 2023. This is likely due to the redefinition of urban areas and the inclusion of rural areas in urban areas. The area of water bodies decreased by 26.55 percent between the years 2019 and 2023 (Fig. 25). This is likely due to the encroachment of waterbodies by human activities, such as agriculture and urbanization.

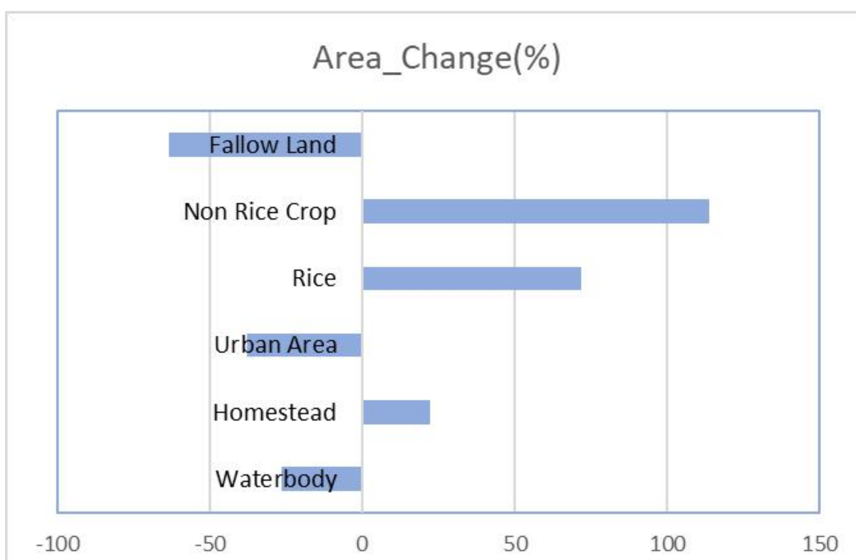


Fig. 25: Land Use Land Cover Change of Amtali Upazila over 2019 to 2023

Table 11: Rice Area Transformation of Amtali Upazila from 2019 to 2023

Transformation of Rice Area	Area (ha)
Non Rice - Rice	1362.69999
Rice - Rice	71.681154
Rice - Non Rice	762.514966

Table 11 sheds light on some notable changes in Amtali Upazila's rice crop area between 2019 and 2023. The notable growth of converted non-rice regions into rice production (Non-Rice-Rice), totalling 1362.69999 hectares, contrasts with the stable rice area (Rice-Rice), which spans 71.681 hectares. Furthermore, 762.515 hectares are taken up by the conversion of rice fields to non-rice usage (rice-non-rice).

Causes of Increasing Rice-Cultivated Area:

Through the survey, some causes of increasing rice cultivated area were found. Such as:

- Farmer training arranged by different Government Organizations and Non-Government Organizations
- Government subsidy and free seed, and fertilizer delivery by Bangladesh Rice Research Institute (BRRI) and the Department of Agricultural Extension (DAE)
- Irrigation facility increased by BRRI coastal irrigation project and other Government Organizations
- Stress-tolerant rice variety development by BRRI

Conclusion

For five years, Amtali Upazila's rice production areas have seen several notable changes that have revealed the dynamic nature of the area's agricultural practices and land use. Although the continuous rice farming stayed steady, there was a notable increase in the more recent rice cultivation zones, which were mostly homesteads, urban areas, non-rice crops, and fallow areas. This impressive expansion indicates that despite socioeconomic and environmental constraints, rice farming has become more popular in the area.

Project 5: Capacity Building through Training

Activity 5.1: Training Program on Experimental Data Analysis

(In collaboration with Training Division)

- Md. Ismail Hossain, Md. Abdullah Al Mamun, Md. Abdullah Aziz, Md. Abdul Qayum, Md. Sahadat Hossain and Shanaj Parveen

Introduction

Training is an important and only the method for developing skills on research. To set up the experiment, collecting, compiling, reporting, analyzing and presenting of data training helps to increase the accuracy of the finding.

Objectives

1. To train up BRRI personnel on experimental data analysis using different statistical software.
2. To make BRRI personnel self-dependent on experimental data analysis.
3. To developed skills on research planning, program and report writing.

Methodology

Enhanced lectures and discussion, group discussion, review and feedback were the training method. Different statistical software was used for experimental data analysis. The course of schedule by two parts one for advanced MS Excel data management and analysis including data entry, coding and naming; Basic operations: Use of functional keys Date function 'Text function", "IF ELSE" function Lookup function ('VLOOKUP' and 'HLOOKUP'; Data validation); Conditional formatting; Pivot table in MS Excel for 2 days. Another very interactive session for advance statistical analysis and data management using Programming R (R Studio) was also shared in this training program for 4 days. The application of different packages of R included those sessions like introduction and basic of R and R Studio; Programming R Data frame; Indexing from a vector set; Indexing of data frame; Logical Operators; Arithmetic operators and experimental data analysis including CRD, RCBD single and multiple factors, Split plot design, multiple comparisons of the test (LSD, DMRT, HSD) etc.

Results and discussion

Training program on experimental data analysis has been conducted with the collaboration of Training Division. A total of approximately 30 BRRI scientists were trained about advanced experimental data analysis. The participants of this training were SO and SSO of BRRI HQ and regional stations.

Conclusion

All the participants enabled to handle experimental data and analysis the data accurately by using R programming. Also, increased their capacity on experimental data analysis and data interpretation. Besides, developed their capacity on research planning, program and report writing. So, Skills of BRRI personal on experimental data analysis have been enriched.

Activity 5.2: Training Program on Multivariate Data Analysis

(In collaboration with Training Division)

- Md. Ismail Hossain, Md. Abdullah Al Mamun, Md. Abdullah Aziz, Md. Abdul Qayum, Md. Sahadat Hossain and Shanaj Parveen

Introduction

Multivariate data analysis is a type of statistical analysis that involves more than two dependent variables, resulting in a single outcome. This training gives us the clear and straightforward guideline to conduct experimental design for MVA and data analysis. Also helps us to increase the accuracy of the finding.

Objectives

1. To train up BRRI scientists on multivariate data analysis using different statistical software.
2. To give clear and straightforward guideline of how to conduct experimental design for MVA.
3. To make BRRI scientists self-dependent on multivariate data analysis.
4. To developed skills on research planning, program and report writing.

Methodology

Enhanced lectures and discussion, group discussion, review and feedback were the training method. Different statistical software was used for the multivariate data analysis. Dot plot, Bar plot, Graphical view of Heat map, Graphical view of the Correlation matrix and correlation plot, GGE Biplot Analysis, Principal component analysis; Cluster analysis, multi-location trail analysis were discussed, path analysis, Genetic variability and divergence analysis were the topics of this training program. Also used some widely used R packages such as “ggplot2”, “metan” “cluster”, “factoextra”, “FactoMineR” “doebioresearch” “readxl”, “readr” etc were used to perform advanced multivariate data analysis PCA, cluster, CVA, D^2 and path analysis etc.

Results and discussion

With the collaboration of Training Division, the training program on multivariate data analysis has been conducted for 5 batches including 10 participants for each batch. A total of approximately 50 BRRI scientists were trained about advanced multivariate data analysis. The participants of this training were SO and SSO of BRRI HQ and regional stations.

Conclusion

The participants enabled to handle experimental design for MVA and analysis the multivariate data independently by using R programming. Then, developed their capacity on multivariate data analysis and data interpretation. Also, developed their capacity on research planning, program and report writing. So, knowledge and skills of BRRI scientists on multivariate data analysis have been enriched.

Project 6: Computer Programming, Software Development and Digitization

Activity 6.1: Develop a dynamic web application for visualizing and analyzing the rice disease surveillance data

(In collaboration with Plant Pathology Division)

- Md. Abdul Qayum, Md. Ismail Hossain, S. M. Mostafizur Rahman and scientists from Plant Pathology division

Introduction

Plant Pathology Division collect disease data through ODK (an online platform). We are engaged with Dr. Ashik Iqbal Khan, PSO, Plant Pathology Division for collecting the data in the online platform. Using this data, we want to develop a digital platform that visualize and analyze the data dynamically.

Objectives

- Develop a dynamic web application for visualizing and analyzing the rice disease surveillance data

Methodology and Software Development Progress

Develop a web application integrating R/python and Batch Script (background software) with XAMPP server, MySQL Database, HTML, PHP, JQuery and JavaScript programming languages. The disease surveillance data will be used for this dynamic web application. The system is not hosted yet. The Home page, Menu bar with some view is shown in the following figure 26.

Fig. 26: Pictorial view of the visualizing and analyzing the rice disease surveillance data Software

Conclusion

The journey started to develop the home page of the dynamic web application. By this web application software scientists/users can easily and quickly find out the disease scenario in Bangladesh. This software not hosted yet.

Activity 6.2: Digitalized Tour Distance Calculation System from BRRI HQ

- Md. Abdul Qayum, Md. Ismail Hossain and S. M. Mostafizur Rahman

Introduction

All the service needs to digitalize for the execution of the election manifesto (Digital Bangladesh) of the government of Bangladesh. Now tour bill were prepared using tour distance matrix. But in the distance finding system was quite time, cost, visit and labour consuming. So that tour distance calculation system needs to make digitalized. Under this activity we developed a web application for calculation tour distance system from BRRI HQ.

Objectives

- To develop a digital tour distance calculation system for BRRI HQ

Methodology and Software Development Progress

Develop a web application using XAMPP server, MySQL Database, HTML, PHP, JQuery and JavaScript programming languages. The Government published distance matrix were used in this web application. The system is ready and host in the BRRI LAN (172.16.100.106/MIS_BRRI/tour_distance/). The Home page, Menu bar with some view is shown in the following figure 27.

Fig. 27: Pictorial view of Tour Distance Calculation System Software

Conclusion

The journey started to develop the home page and some of the important pages of the web application. By this web application software travellers/scientists/officers/stuff/users can easily and quickly find out their travel distance according to the government order.

Activity 6.3: Update the web application to calculate the Stability Index for BRRI Stability Model

- Md. Abdul Qayum, Md. Ismail Hossain, S. M. Mostafizur Rahman, Md. Abdullah Aziz and Md. Abdullah Al Mamun

Introduction

In the Genotype (Variety) development and release process Stability Analysis one of the most important characteristics for the genotypes. Assuming this importance Agricultural Statistics Division of BRRI developed a Stability model that was a great achievement of the division. But the analysis procedure to find out the stability index of genotypes is very laborious and time consuming by the develop model. We already developed a computer program using R software to calculate the stability index for BRRI stability model. But for this R programming all users need an R environment setup in their machine (PC/Laptop). To overcome this complexity, we want to develop a web application software so that one can easily calculate the stability index of variety/genotype using BRRI developed stability model under this study.

Objectives

- To update the web application to calculate the stability index for BRRI stability model.

Methodology

Develop a web application integrating R and Batch Script (background software) with XAMPP, HTML, PHP, JQuery and JavaScript. For using this web application, user needs the arrangement of the data in the specific format to calculate the stability index for BRRI stability model. At least three location, genotypes and years average data needs to perform this model and the data format is shown in the following table 12.

Table 12: Sample data format table

Locations ↓	Genotypes ↓	Average Yield of Genotype				
		1st Year	2nd Year	3rd Year	....	Last Year

Software Development Progress

The Home page, Menu bar with some view is shown in the following figure 28. Location map preparation, Stability model view, Model Calculation and Stability result view and print option developed complete. This software not hosted yet.

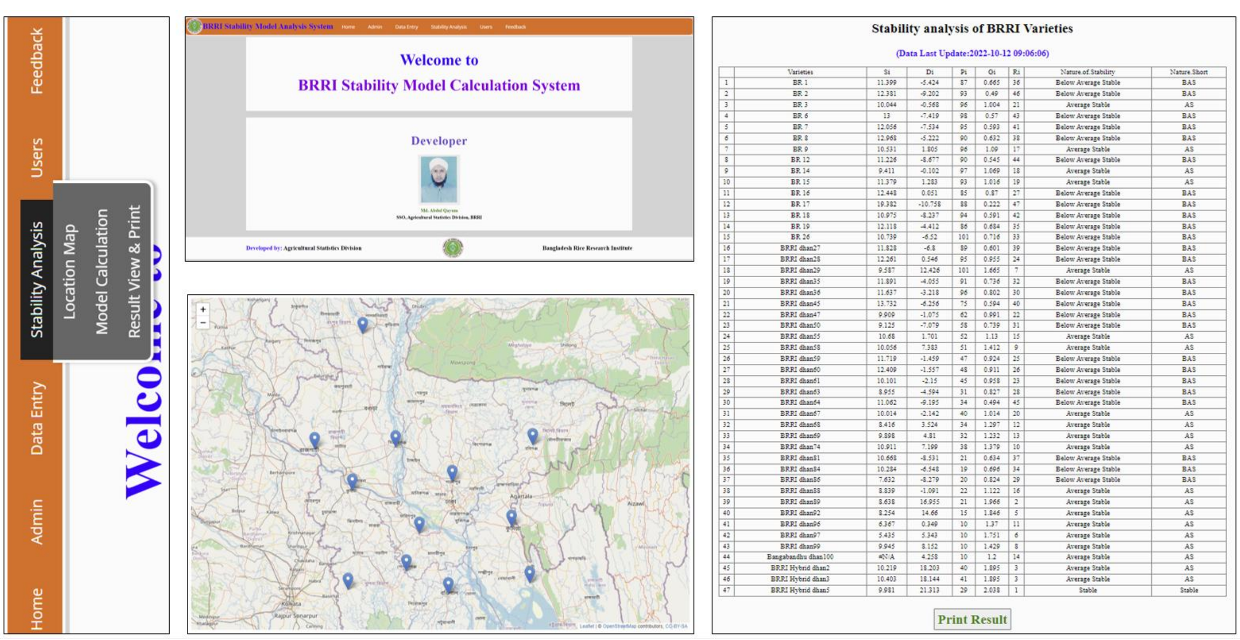


Fig. 28: Pictorial view of the Stability Analysis Web Application Software

Conclusion

Update the web application to calculate the stability index for BRRI developed stability model. By this web application software, we can easily and quickly calculate the stability index if the data available in the require format. This software saves resources to calculate the stability of genotypes.

Activity 6.4: Update the Platform for BRRI Developed Management Information System (MIS)

- Md. Abdul Qayum, Md. Ismail Hossain and S. M. Mostafizur Rahman

Introduction

Already BRRI developed many web applications. (1) Salary Management System 2 Version (2) Labour Management System 2 Version (3) Budget Management Software (4) Quota Management Software (5) CL Application Management Software (6) Stability Analysis for BRRI Model Calculation Software, also try to develop (7) Rice Disease Monitoring System Software and (7) Tour Distance Calculation System Software. All the above developed software hosted in different Server with different address. So, sometime user face difficulty to find them. Also need more link to include in the BRRI website. Then, the time demand to develop a unique platform for all the BRRI developed MIS Software. Under this activity we developed a unique platform for all the developed software so that one can easily find out and used their needed software.

Objectives

- To update the unique platform for BRRI developed MIS

Methodology and Development Progres

This unique platform developed by using XAMPP, HTML, PHP, Javascript (JS) and JQuery. The platform is ready and host in the BRRI LAN (172.16.100.106/MIS_BRRI/). A screenshot of the unique platform shown by the figure 29.

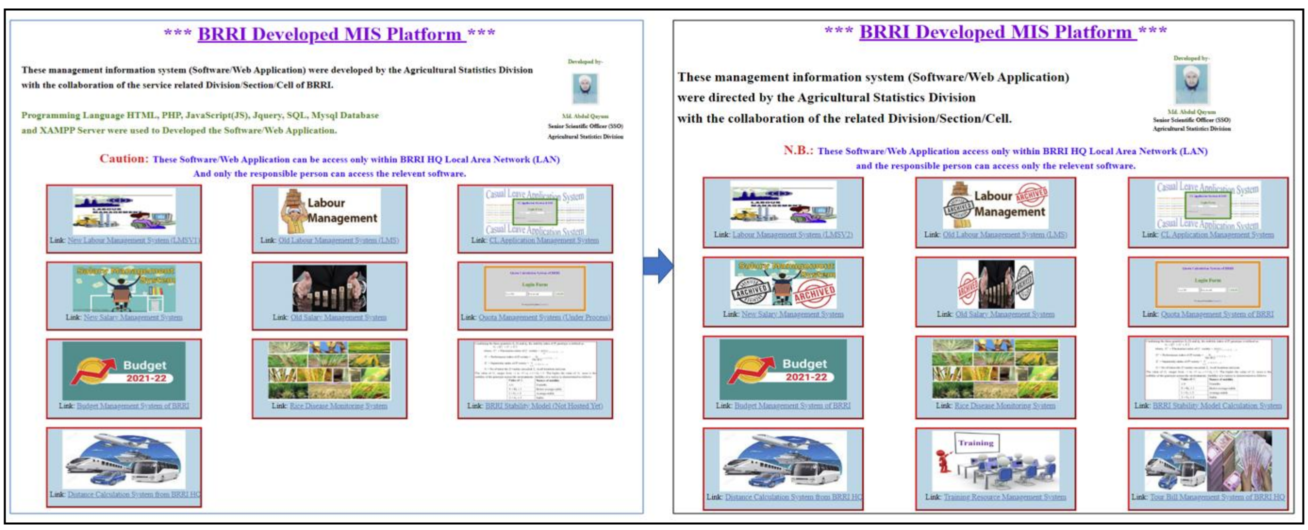


Fig. 29: Pictorial view of the updated unique platform for BRRI developed all MIS Software

Conclusion

By this unique platform for all the BRRI developed MIS software, users can easily and quickly find out and used their needed software. This platform saves time of the users.

Activity 6.5: Digitalized quota management system of BRRI

- Md. Abdul Qayum, Md. Ismail Hossain, S. M. Mostafizur Rahman, Nuraiya Kulsom and one from administration section

Introduction

Employee recruitment is a continuous process of an organisation. Quota management is one of the crucial events for recruit manpower of an institute. To recruit the new employee for the vacant post of the organization, Administration and Common Service division continuously put their hard work for this management. It is great pleasure to us that this quota calculation work has been done by the Agricultural Statistics Division. The calculation system was very sensitive and manually it is a very laborious and time consuming. So, the time demand is that a digital system must developed for maintaining, updating and calculating the quota system. In this circumstance, Agricultural Statistics Division developed "Digitalized Quota Management System" for BRRI under this activity to manage the quota calculation system for BRRI.

Objective

1. To develop a digital quota management system for BRRI

Methodology

This is a web application and developed by using XAMPP, HTML, PHP, JavaScript (JS) and JQuery. The system already starts to use. Now the system is in live in the BRRI LAN (172.16.100.106/MIS_BRRI/quota/). A screenshot of the unique platform shown by the figure 30.

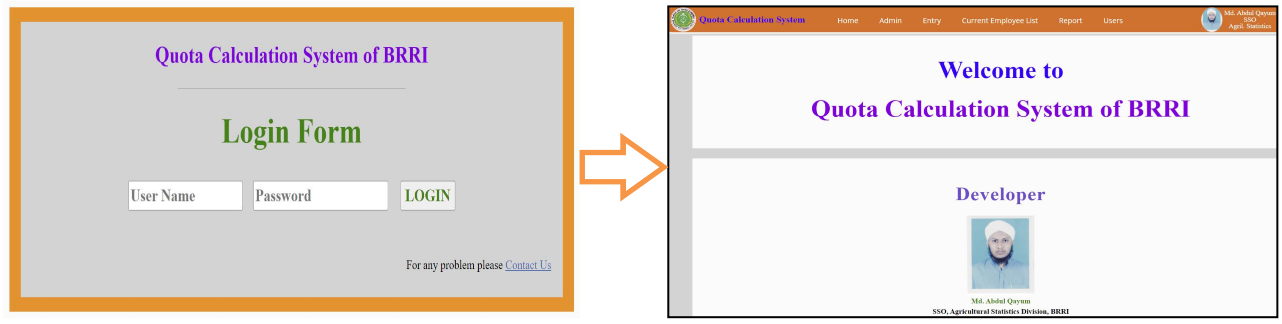


Fig. 30: Pictorial view of the Login and Home Page of the Quota Management System of BRRI

Progress

- Quota management system software already been Developed and hosted in BRRI LAN
- Quota calculation and report preparation already start by this software

Conclusion

The respected user can input the employee related information and can see all the report with printable format after login in the system. It is easy to access, accurate, consistent and most flexible quota management system in comparison to the existing system.

Activity 6.6: Digitalized salary management system of BRRI

- Md. Abdul Qayum, Md. Ismail Hossain, S. M. Mostafizur Rahman and one from Finance & Accounts Section

Introduction

One of the most important works of Finance and Accounts (F&A) Division of BRRI HQ is to prepare the monthly salary of the HQ employees. For this, they collect employee's salary related information and preserve in the salary register books. After that they prepared salary related report. Some of the report prepared manually and some of the report prepared using software. Unfortunately, the software failed to execute. So that, these existing practices and procedures took long time to prepare the salary related report in every month. In this circumstance, Agricultural Statistics Division developed "Digitalized Salary Management System" for BRRI HQ employee.

Objective

1. To digitalized "New Salary Management System" for BRRI HQ Employee

Methodology

The Salary Management System is a web application developed using XAMPP, HTML, PHP and JavaScript (JS). Now the system is in live in the BRRI LAN (172.16.100.106/ MIS_BRRI/salary). The system included BRRI HQ employee information, salary preparation with report generating system, wages report and other reports with printable format (Fig. 31 and 32).

Progress

- The Salary Management System were archived now.

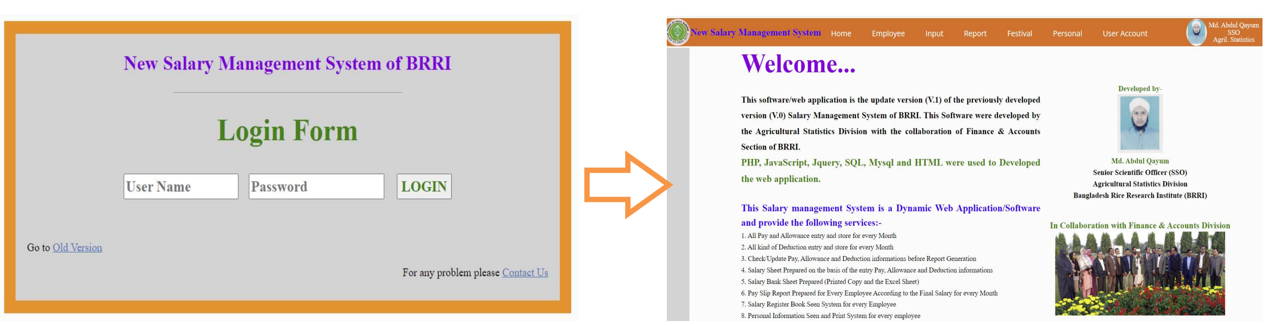


Fig. 31: Pictorial view of the New Salary Management System of BRRI HQ Employee

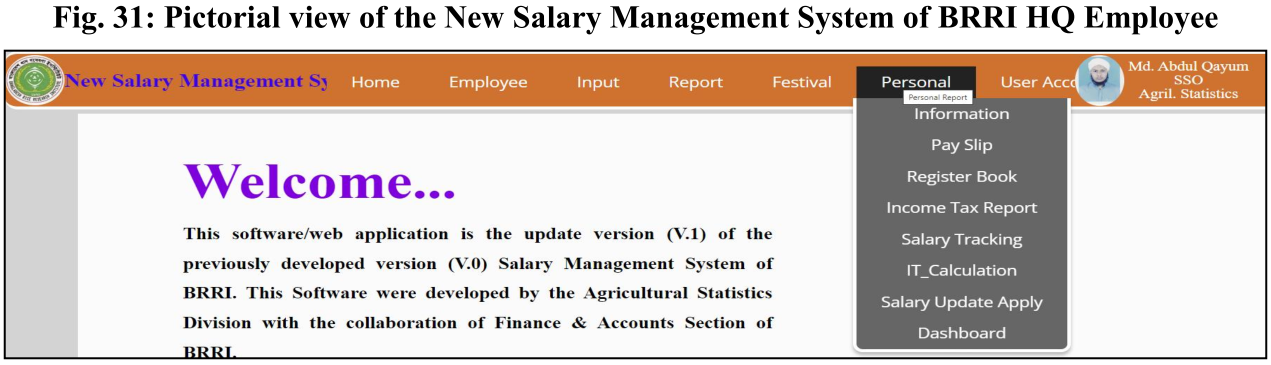


Fig. 32: Personal menu features pictorial view

Conclusion

Salary prepared by this software up to June/2023 date but some of the employees' information were used generated from this software for iBas++ Software. All the salary related report stored in the database. The total 611785 information preserved in the database.

Activity 6.7: Digitalized labour management system of BRRI

- Md. Abdul Qayum, Md. Ismail Hossain and S. M. Mostafizur Rahman

Introduction

Farm Management Division of BRRI works for labour management. The division collect labour attendance data and prepared labour wages according to that collected attendance. The personnel of the division work hard for entry, updates, monitoring and reporting of the attendance as well as preparing the wages report manually. So that, many of these existing practices and procedures take many times to prepare wages report related many sheets per month. In this circumstance, Agricultural Statistics Division developed an update version (LMSV1) of the digitalized labour management system (LMS) for BRRI HQ under this program.

Main Objective

1. To update "Labour Management System (LMS)" of BRRI as user need.

Specific Objectives

1. Update "digitalized Attendance system of BRRI Labour" as user need.
2. Update "Digitalized and Automated Labour Wages System" as user need.
3. Update "Digital Labour Data Centre"
4. Modify the Web Application as user need.

Methodology

The New Labour Management System (lmsV1) is a web application developed using XAMPP, HTML, PHP, JavaScript (JS) and JQuery. In this digital system all the division/section/cell entry, update and approve the labour attendance (Fig. 33). After approved the labour attendance by the head of the division/section/cell, the software system automatically prepared the attendance report and all the report related to labour wages (Top Sheet, Overtime Summary Sheet, Deduction Report, Final Bill Report, Bank Sheet Report, etc.) in printable format after entry the electricity-gas bill by Building & Construction Division and other deduction by Finance and Accounts Section.

Progress

- Web Application software already been Developed and hosted in a server (BRRI LAN)
- The application is already running.
- An update version of labour management system (lmsV2) was developed

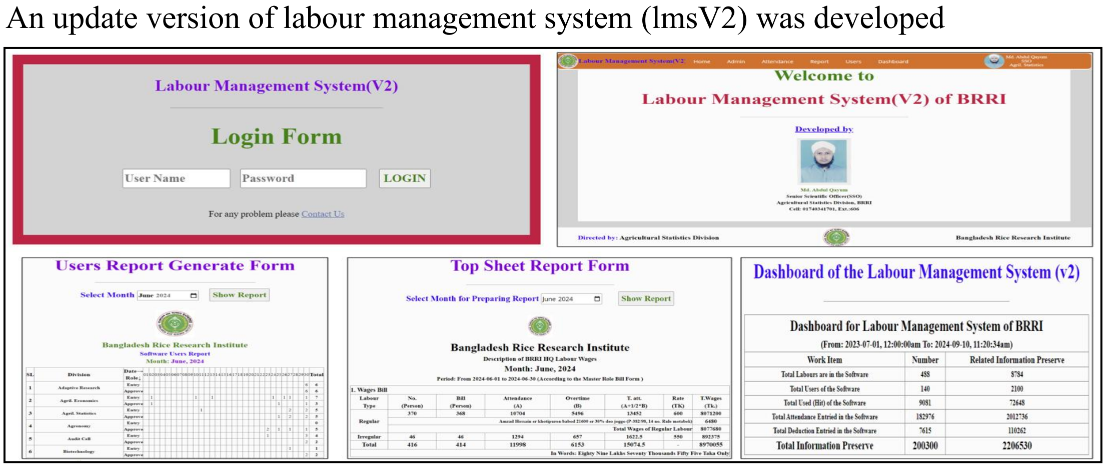


Fig. 33: Pictorial view of the New LMS (lmsV2) of BRRI HQ

Conclusion

Total 140 users were used 2100 times of the software and 182976 attendances were entries about 488 labours. Also, total information 2206530 were preserved in the database. A new feature 'user's information' was including in the user account menu of the software.

Project 7: Information and Communication Technology (ICT)

Activity 7.1: Smart profiling of rice varieties in Bangladesh

(in collaboration with Plant Breeding, Hybrid Rice, Biotechnology, Agronomy, Plant Physiology, Plant Pathology, Entomology, GQN and Rice Farming System div. of BRRI)

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, Moin Us Salam, Khondoker Mokaddem Hossain S. M. Mostafizur Rahman, Mrs. Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Objectives

1. To explore mechanism for profiling rice varieties with respect to environmental suitability, physical and physiological characteristics, yield potential and tolerance to abiotic and biotic stresses;
2. To electronically present and disseminate the newly developed smart profiled varieties information through a dynamic web application and mobile app to stakeholders;
3. To manage, maintain and host mobile and web app at server.

Introduction

The yield of rice is predominantly driven by variety. High yielding varieties (HYVs) ensure increased yield for the farmers. The BRRI, predominantly, and the BINA, partly, together with few private companies have been playing the gigantic role for releasing suitable rice varieties for the farmers of Bangladesh. The number of such varieties currently stands over 108. These varieties should be used in specific environments to ensure their yield potentials. Besides, the varieties have various life cycle (duration between sowing and harvesting) to fit into desired cropping system especially in adverse environments, such as the disaster-prone zones. Furthermore, some varieties may be good in yield, but prone to pest and diseases. In fact, the choice of a variety to sow has a significant impact on the sustainability and profitability of rice. Therefore, farmers require comparison between the varieties to choose the right one for their specific circumstances.

Currently, information on the rice varieties is available from BRRI and BINA in the form of booklets and/or leaflets. With a hard copy, it is very difficult for the farmers to compare one variety with the other. Besides, the ability to quickly update such information on newly-released varieties has been limited. Therefore, a mechanism needs to be explored for smart delivery-access of variety information.

According to work plan 8.4.3 activity of National ICT Policy-2018 has stated that it was developed a single and complete agricultural input and cropping plan with integrated advisory service through real-time data feeding system. 5G were introduced by 2021-23. Introduction of upcoming technologies like-artificial intelligence, robotics, big data, block chain and IoT were expedited. Many activities are ongoing based on technology such as digital agriculture platform generating base data for crop field condition, crop stage mapping using satellite image processing and vertical agriculture for prediction mapping (National Strategy for AI Bangladesh 2019-2024). So BRRI has taken initiative to develop a mobile app named 'Rice Profile' for smart profiling of rice varieties in disaster-prone zones of Bangladesh.

Methodology

Information of 108 BRRI released varieties were collected from published and unpublished literature, and through personal contact with the relevant scientists of the institute. The information included potential yield, physical characteristics, disease tolerance, insect-pest tolerance and abiotic stress tolerance. The varieties were grouped under 17 rice types (Hisham et al., 2020): (i) Favourable Boro (short duration), (ii) Favourable Boro (Long duration), (iii) Saline Boro, (iv) Cold tolerant (Haor); (v) Cold tolerant (Northern and Western regions); (vi) Healthier rice (Boro); (vii) Favourable Aman; (viii) Saline Aman; (ix) Flash flood; (x) Drought; (xi) Tidal submergence; (xii) Deepwater; (xiii) Healthier rice (Aman); (xiv) Upland rice; (xv) T. Aus; (xvi) Healthier rice (Aus); (xvii) Premium quality rice. The information will consolidate in MS-Excel spreadsheet. The system is based on approved Software Requirement Specification (SRS) and System Designing Documents (SDD). At the development stage, it follows the standard code convention, code level documentations, header of each file, algorithms, interfaces, code compression. Application Programming Interface (API) is made shareable to with another platform.

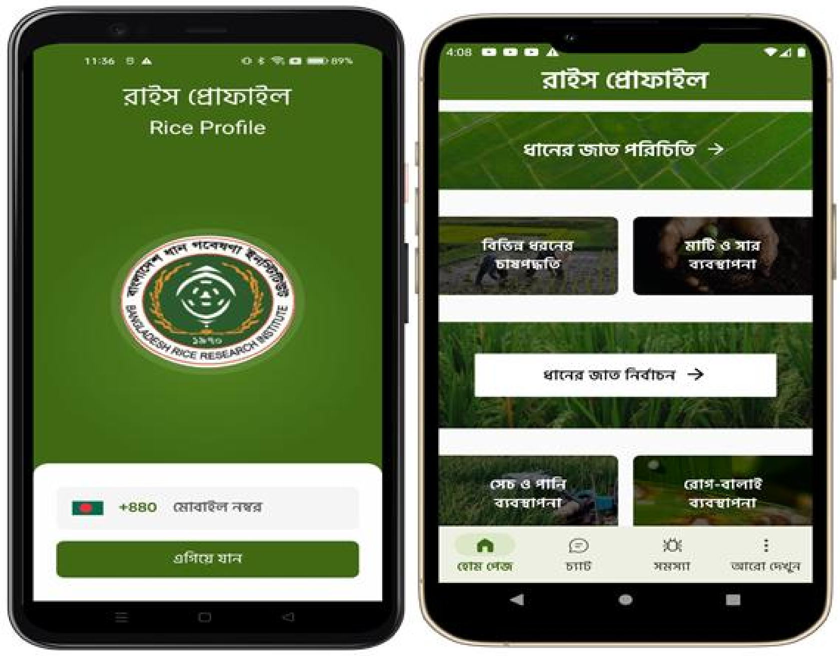


Fig. 34: 'Rice Profile' mobile app

Progress

- Already included 07 (Seven) rice type [Saline Boro, Cold Tolerant (Haor), Cold Tolerant (Northern & Western), Saline Aman, Flash Flood and Tidal submergence] out of 17 rice type information in mobile app with varietal information through this profiler (Fig. 34).
- An easy comparison system of the varieties has been developed for a specific environment and quickly picking up the preferred one(s).

Activity 7.2: **New version of rice knowledge bank (RKB) mobile Apps**

-S. M. Mostafizur Rahman, Md. Ismail Hossain, Md. Mahfuz Bin Wahab, Mrs. Kabita, Md. Asadullah, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

A mobile application (also called a mobile app) is a type of application designed to run on a mobile device, which can be a smartphone or tablet computer. Even if apps are usually small software units with limited function, they still manage to provide users with quality services and experiences.

Objectives

1. To develop the new version of RKB mobile apps.
2. To develop a push notification system.
3. To manage and maintain RKB Mobile apps.

Methodology

The mobile application of RKB (Rice Knowledge Bank) is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. RKB is a dynamic mobile application and also mobile base knowledge bank. RKB application has been developed with the information of BRRI released rice varieties, modern rice cultivation and agricultural machinery technologies, pest and disease management, soil and fertilizer management, irrigation and water management, quality rice seed production management, training and publications. RKB is an interactive tool for farmers, extension workers, scientists/researchers, teachers, students and other users who want to learn and control insects & diseases and other problems that can occur in rice, and how to manage them.

Progress

- Feedback meeting has been held between BRRI and MCC Ltd.
- A proposal has been submitted to the LSTD project.

Activity 7.3: **Sensor-based rice pest management through Artificial Intelligence (AI) technology of BRRI**

(In collaboration with Plant Pathology, Plant Physiology, Entomology, Soil Science and Agronomy div.)

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Mrs. Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Objectives

- To develop AI based mobile and web App for BRRI.
- To identify AI scopes in rice research engaging scientists, extension worker and farmers.
- To manage, maintain and host AI based mobile and web app at server.

Introduction

Bangladesh is embracing Artificial intelligence (AI) for the digitalization of the nation. AI is the simulation of human intelligence processes by machines, especially computer systems. The high-yielding varieties and agronomic good practice play a vital role through modern technologies like IoT (internet of things), machine learning method (MLM), artificial intelligence (AI) and big data which can create a dynamic shift towards modernizing agriculture. The crop and soil monitoring system will be developed through AI application. Particular applications of AI include expert systems, speech recognition & machine vision. According to work plan 8.4.3 activity of National ICT Policy-2018 has stated that it will develop a single and complete agricultural input and cropping plan with integrated advisory service through IoT, Sensor, AI, Big Data analytics and real-time data feeding system. 5G will be introduced by 2021-23. Introduction of upcoming technologies like-artificial intelligence, robotics, big data, block chain and IOT will be expedited. Many activities are ongoing based on technology such as digital agriculture platform generating base data for AI, IoT for crop field condition, crop stage mapping using satellite image processing and vertical agriculture for prediction mapping (National Strategy for AI Bangladesh 2019-2024). So, BRRI has taken initiative to develop a sensor-based rice pest management through artificial intelligence (AI) technology.

Methodology

BRRI Rice doctor mobile and web application already developed (Fig. 22) where BRRI released rice varieties, modern rice cultivation, insect & pest, disease and agricultural machinery technologies information has included. But it is an interactive tool for farmers, extension workers, scientists/researches, teachers, students and other users when the hi-tech initiated. It has introduced hi-tech solution through Artificial Intelligence (AI) for controlling disease & insect by image analysis. The dynamic mobile and web application automatically provide the required problem-solving solution of rice disease and pest related with proper management within one to one and a half minutes. So, image data collection process is continuing from at least three districts of different region (Gazipur sadar, Rajshahi, Rangpur and Cumilla) for accurate result.

Progress

1. Mobile app has been developed and uploaded into Google Play Store and Apple App Store as ‘Rice Solution’ (Fig. 35).
2. Developed image analysis sensor through Artificial Intelligence (AI) and Machine Learning Method (MLM) under 4IR (4^{th} Industrial Revolution) technology;
3. Already stored and trained approximately 30000 images of several disease and insect through AI and MLM technology.

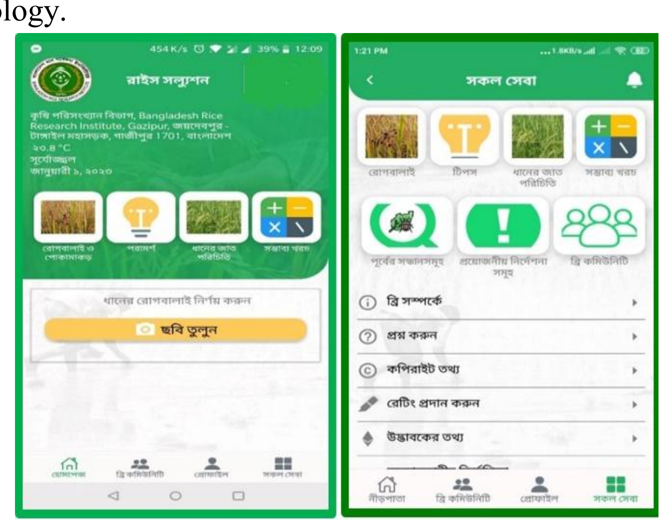


Fig. 35: ‘Rice Solution’ mobile app

Activity 7.4: Develop a new website for BRRI

-S. M. Mostafizur Rahman, Md. Ismail Hossain, Md. Mahfuz Bin Wahab, Mrs. Kabita, Md. Asadullah, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

A website is a collection of web pages and related content that is identified by a common domain name and published on at least one web server. Such as google.com, yahoo.com, facebook.com and amazon.com. All publicly accessible websites collectively constitute the World Wide Web (www). There are also private websites that can only be accessed on a private network, such as an internal website for its users. Websites are typically dedicated to a particular topic or purpose, such as news, education, commerce, entertainment, or social networking. Hyperlinking between web pages guides the navigation of the site, which often starts with a home page. Users can access websites on a range of devices, including desktops, laptops, tablets, and smartphones. The software application used on these devices is called a web browser. Some websites require user registration or subscription to access the content. Examples of subscription websites include many business sites, news websites, academic journal websites, gaming websites, file-sharing websites, message boards, web-based email, social networking websites, websites providing real-time data, as well as sites providing various other services.

Objectives

1. To develop a new website for national and international seminars and symposiums.
2. To manage domain or sub-domain for the new website.
3. To host the new website at server.
4. To manage and maintain the new website.

Methodology

A new website was developed by the ICT cell, Agricultural statistics division (Fig. 36). The website is an interactive platform for scientists, researchers, DAE personnel, teachers, students and others who want to get information and also submit their papers, abstracts and posters for attaining the international and national seminars & symposiums. The software is visible 24/7/365.

Progress

Bangladesh Rice Research Institute arranges national and international seminars and symposiums. Having a website makes it very easy for people to find information and also submit their papers, abstracts and posters for attaining national and international seminars and symposiums. Read up about BRRI, discover what BRRI does, and answer a bunch of questions they have. By having a website people will be able to get information about BRRI when they search on a search engine like Google, Yahoo or Bing. The website has been used to get information and submit their papers, abstracts, posters and others.

Fig. 36: New website for BRRI

Activity 7.5: Strengthening Cyber Security System for BRRI

-S. M. Mostafizur Rahman, Md. Ismail Hossain, Md. Mahfuz Bin Wahab, Mrs. Kabita, Md. Asadullah, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Cyber security system is the technique of protecting a server, computer network, software, application, files, source code and database from unauthorized access, hacked or attacked. Virtual Private Network (VPN) provides safe and encrypted connections over private and public networks that transport data securely. A virtual private network (VPN) protects data and identity over public networks by creating a private network from a public internet connection. VPNs mask internet protocol (IP) addresses. So, it is impossible to link it to online activity via IP detection. A VPN tunnel is an encrypted connection between a VPN client (local computer) and the server. Since the connection is encrypted, nobody is able to intercept, monitor, or alter the communications.

Objectives

1. To develop Virtual Private Network (VPN) for BRRI.
2. To develop VPN tunnel for BRRI.
3. To develop secure remote connectivity for BRRI.
4. To manage and maintain cyber security system.

Methodology

For strengthening the Cyber security system, developed design and architecture using AutoCAD and graphics software's. Shell program has been used for Virtual Private Network and configuration of the outer and inner tunnels. This Tunnel was used for encrypted communication between client and server. Remote connectivity between BRRI and national data centre was developed through Windows platform.

Progress

- Configuration of Virtual Private Network (VPN) is completed successfully.
- Configuration of outer and inner tunnels are completed successfully.

Conclusion

After develop cyber security system nobody can trace the server (back-end server) of any location in the world. When client point and server point are connected through VPN, only that time server (back end or admin panel or c panel) will be visible for only the client computer. So, it will be possible to protect completely the BRRI's server such as mail server, webserver, website, FTP server, application and other web-related servers and all servers as well as all data will be safe and secured.

Activity 7.6: **BRRI Alapon Telephone Directory Mobile App of BRRI**

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Mrs. Kabita, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Alapon is a secured inter communication platform. Through a controlled network, a Govt. officer with Alapon App can find any other Govt. officers based on hierarchy using the directory service instantly, communicate with him over both voice & video call and share official files securely. It can download on any device and register using their National Identification (NID) Number which will synchronize all the details from the database accordingly. Moreover, a user can plug in the service using data network, communication cost becomes relatively low while ensuring strong user association within service network. So BRRI took the initiative to develop 'BRRI Alapon' mobile and web application for proper communication.

Objectives

1. To develop telephone directory mobile app for BRRI.
2. To communicate through mobile app via voice call, video call, email or SMS.
3. To provide location sharing through mobile app.
4. To provide all types of meeting, seminar etc notice via SMS through mobile app.

Methodology

The BRRI telephone directory mobile app named *"BRRI Alapon"* is developing for BRRI official. They are able to communicate with each other through this app like imo, Viber, Whatsup, WeChat etc. The app has features like chat, online calls, group messaging and location sharing. *"BRRI Alapon"* is available for free download in App Store (*iStore*) and Google play store for *Android* phone user. BRRI officials are able to download it with their valid and active mobile numbers on devices which they provided for the official database. The data has been collected from all division, section and regional station of BRRI. The data has included with name, designation, mobile number, email address, present posting, date of birth and blood group. The data was compiled into MS Excel format.

Progress

- The mobile app development named 'BRRI Alapon' for Android user under Google play store and iPhone user under Apple apps store platform process is continuing.
- Already database has been developed. (Fig. 37).
- All types of data have been collected from divisions, sections and regional stations of BRRI for developing the telephone directory mobile app.
- The mobile application has been completely funded by ICT Division.

			Director General			
ড. মোঃ শাহজাহান কবীর	মহাপরিচালক	০১৭১২-২৮০০৮৩	kabir.stat@gmail.com dg@brri.gov.bd	3.32301E+12	O+	[illegible]
খুরশীদ সিহাব	ব্যক্তিগত সহকারী	[illegible]	bd.sihab@gmail.com	3276772682	B+	11-11-12
Md. Rabiul Islam	অফিস সহায়ক	[illegible]	rabiulbrri@gmail.com	7350214784	AB+	[illegible]
Md. Rafiqul Islam	গাড়ী চালক	[illegible]	mri849094@gmail.com	7794274949	A+	08-01-17
			Director Research			
ড. তমাল লতা আদিত্য	পরিচালক (গবেষণা)	[illegible]	directorresearchbrri@yahoo.com tamaladitya@yahoo.com	[illegible]	O+ve	[illegible]
ড. মুন্নুজান খানম	উচ্চ শিক্ষা ও গবেষণা সমন্বয়কারী	[illegible]	munnujan_khanam@yahoo.com	[illegible]	O+ve	[illegible]
ড. এবিএম জাহিদ হোসেন	এসএসও	[illegible]	abmz_hossain@yahoo.com	[illegible]	B+ve	[illegible]
মোছাঃ আছমা খাতুন	প্রশাসনিক কর্মকর্তা	[illegible]	asma.brri@gmail.com	[illegible]	B+ve	[illegible]
মোঃ নূর এ আলম শাহীন	অফিস সহকারী কাম কম্পিউটার মুদ্রাক্ষরিক	[illegible]	shahinalambdg@gmail.com	[illegible]	AB+ve	[illegible]
মোঃ সোহেল রানা	অফিস সহকারী কাম কম্পিউটার মুদ্রাক্ষরিক	[illegible]	amisohel123@gmail.com	[illegible]	AB+ve	[illegible]
			Dircetor Admin			
ড. কৃষ্ণ পদ হালদার	পরিচালক (প্রশাসন ও সাধারণ পরিপর্যা)	01827-172724	Official: da@brri.gov.bd Personal: kphalderr@gmail.com kphalder62@yahoo.com	4609751633	বি (বি পজিটিভ)	28-06-1987
[illegible]	মহাপরিচালকের একান্ত সচিব	01715-257349	Personal mahfujahmed71@gmail.com	4624066835	O (O Negative)	08-01-17

Fig. 37: BRRI Alapon database

Conclusion

After developing the app is secure enough for conversations and optimized to minimize cost for the BRRI officials. Anybody call and exchange messages more securely using this app. App to app call, email and SMS is completely free for user.

Activity 7.7: Vehicle Requisition Management System of BRRI

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

VRMS is an automated scripted transportation management system (TMS). The transportation pool management activities of BRRI are complex and updating the allottee individually in time which is tedious work. The designated official of Transport division is needed to work after office to manage the official vehicle requests and to convey the confirmation to the requester and driver over the phone. VRMS will ease the allotment work using a simple requisition management system that doesn't require any advanced computing skills and the confirmation will be sent using SMS and email.

Objectives

1. To develop vehicle management system (VMS) for BRRI.
2. To inform through SMS, on the basis of demand vehicle at BRRI.
3. To provide SMS for drivers for confirming their upcoming duty.
4. To host VMS at server.

Methodology

Vehicle Requisition Management System (VRMS) which is already updated as Vehicle Management System (VMS) is a transportation pool management activity of BRRI are complex and updating the allottee individually in time which is tedious work. The designated official of Transport division is needed to work after office to manage the official vehicle requests and to convey the confirmation to the requester and driver over the phone. VMS doesn't require any advanced computing skills and the confirmation sent using SMS and email. So that, the requester informed through SMS on basis of demanding vehicle for official or personal purpose as well as driver get confirmation SMS for their upcoming duty. The database has already developed and architecture design has been finalized. The information of all vehicle of BRRI (driver's name, mobile number and vehicle reg. number etc.) has been collected from transport section

Progress

- The mobile app development named 'BRRI VMS' for Android user under Google play store and iPhone user under Apple apps store platform process is continuing (Fig. 38).
- The web application development for desktop user process is also continuing.
- The information of all vehicle of BRRI (driver's name, mobile no, vehicle reg. no etc.) has been collected from transport section.
- The mobile application has been completely funded by ICT Division.

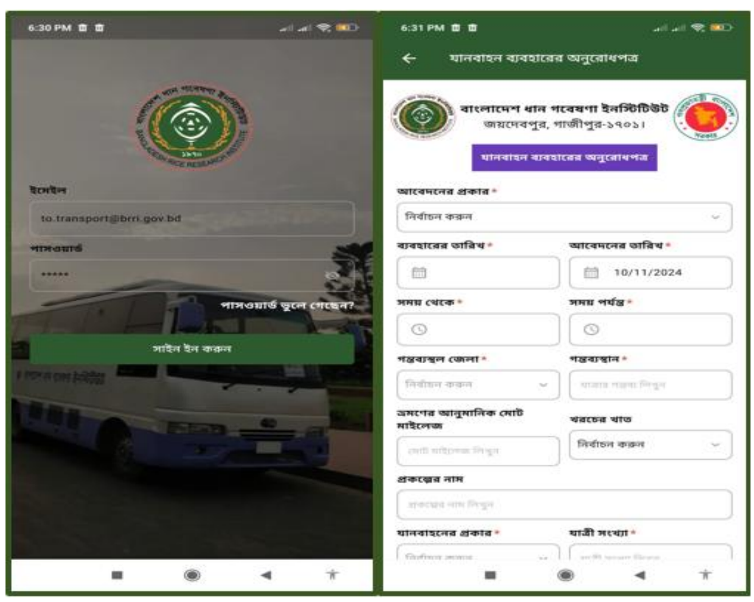


Fig. 38: BRRI VMS

Activity 7.8: Training on Innovation, Service Process Simplification (SPS) and e-Nothi management for enhancing capacity of BRRI employee.

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Mrs. Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Innovation can be defined simply as a "new idea, device or method". Whereas Service Process Simplification (SPS) is a tool to simplify access to public services thereby reducing the time, cost and number of visits (TCV) required for citizens to access them. It is essential to introduce the culture of innovative practices that would accelerate and simplify the BRRI research activities and service delivery process. BRRI has implemented all innovation activities and conducted various training on PSI, SPS and e-Nothi management under under e-Governance and Innovation Work Plan 2023-24 for completing the Annual Performance Agreement (APA) of BRRI.

Objectives

1. To provide various training on public service innovation (PSI), SPS and e-Nothi management to BRRI scientists and officers for developing capacity.
2. To bring qualitative changes in the internal research work process and service delivery in BRRI HQ and respective regional stations.
3. To compile various innovative idea through PSI and SPS training for piloting and replication activities.

Methodology

Innovation and Service Process Simplification (SPS) tool is essential to introduce the culture of innovative practices that would accelerate and simplify the BRRI research activities and service delivery process. Agricultural Statistics Division has implemented all innovation activities and conducted various training on Public service Innovation (PSI), Service Process Simplification (SPS), Simple implementation Project (SIP) and e-Nothi management and several annual innovation work plan of BRRI. Day-long 'Innovation and SPS' workshop has already completed under e-Governance and Innovation Work Plan 2023-24 for completing the Annual Performance Agreement (APA) for all division and sections of BRRI HQ nad BRRI regional stations.

Progress

- Two day-long 'Public Service Innovation' training has completed on 24-25 April, 2024 at BRRI premises (Fig. 39).
- Two day-long 'Service Process Simplification (SPS)' training has completed on 26-27 April, 2024 at BRRI premises.

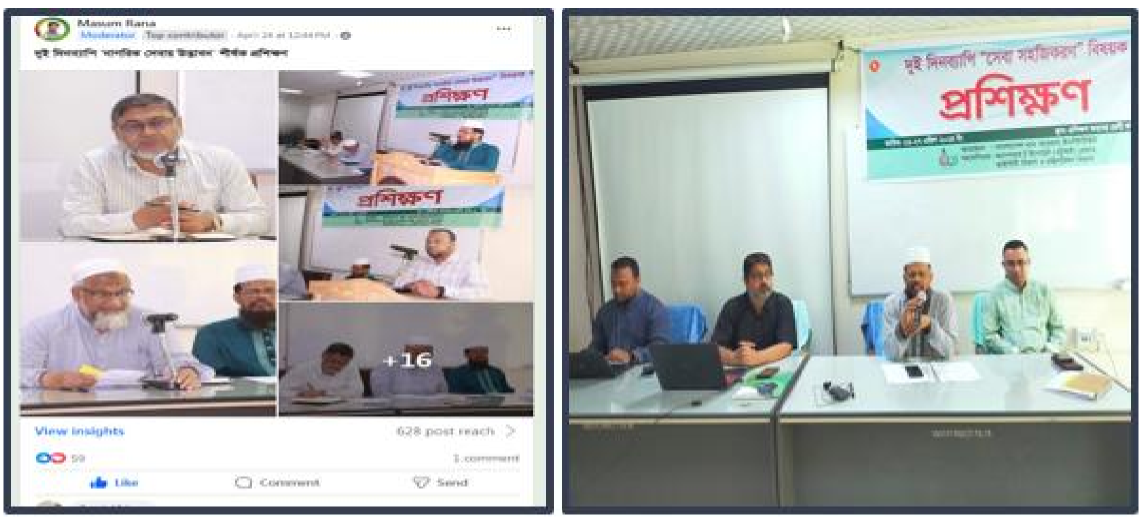


Fig. 39: Training on 'Public Service Innovation' and SPS

Activity 7.9: **BRRI Rice Doctor mobile and web app**

(In collaboration with Plant Pathology, Plant Physiology, Entomology, Soil Science and Agronomy div.)

- Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

The mobile application and web application named 'BRRI Rice Doctor' is being readied to help identify and manage rice crop problems in Bangladesh rice farms. The mobile and web app is now available in both English and Bangla at Google play store. The interactive Rice Doctor App use text and images to help extension workers, farmers, researchers and students diagnose diseases and other disorders affecting rice. It has brief descriptions of the signs, symptoms and management options. So BRRI took the initiative to develop Rice Doctor mobile app, web application and diagnosis tool for proper management of rice production.

Objectives

1. To develop rice doctor Apps for BRRI.
2. To manage and maintain BRRI rice doctor apps.
3. To host BRRI rice doctor Apps at server.

Methodology

Rice Doctor mobile and web application identify disease, insects and other criteria as a diagnostic tool through asking question, off-line content based on insect/diseases list, insect and disease list with image and content, ask question option about rice disease or insect type including voice, image, video and text, question wise push notification/SMS to give feedback about specific problem for user, global push notification and Bangla content reader (Text to speech). Anybody can download from *Google Play Store* of any android mobile phone and then install this app. The app can share through *SHAREit* app from one smart phone to another phone through offline. BRRI has developed Rice doctor mobile app and web application and diagnosis tool.

Progress

- 'BRRI Rice Doctor' developed on 2017 for Google play store using technology of that time.
- The 'BRRI Rice Doctor' mobile and web application has already discarded form Google play store for old technology (Fig. 40 and 41).
- A proposal has prepared for submitting to LSTD project for developing new mobile and web application for Google play store using latest technology.

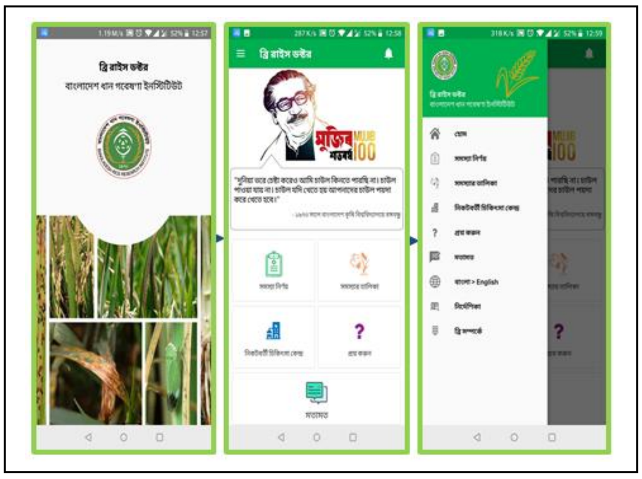


Fig. 40: BRRI Rice Doctor Mobile Apps

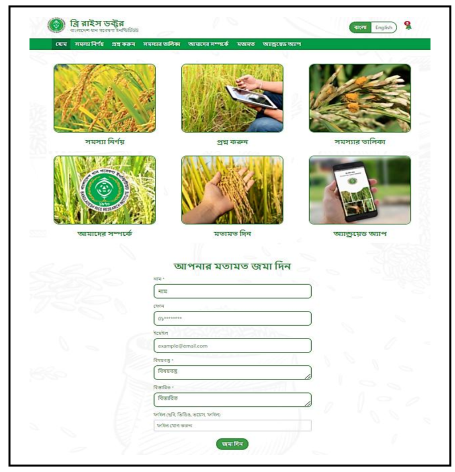


Fig. 41: BRRI Rice Doctor Web Apps

Activity 7.10: BRKB Website Management of BRRI

(In collaboration with training, breeding and others research divisions)

-S. M. Mostafizur Rahman, Md. Ismail Hossain, Md. Mahfuz Bin Wahab, Mrs. Kabita, Md. Asadullah, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Bangladesh Rice Research Institute (BRRI) developed the Bangladesh Rice Knowledge Bank (BRKB) web application. BRKB is a digital extension service that provides practical knowledge solutions, specialized for small-scale farmers in the country. BRKB is a treasure of rice knowledge. This is a dynamic source of knowledge that has been updated regularly to keep consistency with the latest innovations and users' feedback. BRKB showcases rice production techniques, agricultural technologies and best farming practices based on research findings in the country. The BRKB contains rice knowledge to address the regional as well as national issues associated with rice production and training.

Objectives

1. Provide more benefit to all users specially farmers, extension workers, researchers etc.
2. Include more information about rice production and related publications.

Methodology

BRKB Website has managed, maintained and modified by ICT Cell, Agricultural statistics division in collaboration with training, breeding and others research divisions. BRKB is updated regularly with the latest information of rice varieties, modern rice cultivation, pest management, soil and fertilizer management, irrigation and water management, quality rice seed production management, training and publications. Most of the materials i.e., fact sheets, training manuals, booklets, leaflets, brochures, posters have been prepared in Bangla, which are easily understandable to farmers and extension workers. The main sections of BRKB are rice cultivation methods, Boro rice varieties and production methods, Aman rice varieties and production methods, soil and fertilizer management, rice insects and their management, irrigation and water management, photo gallery etc (Fig:11). "BRKB" web application has been developed by WordPress, JAVASCRIPT, HTML, CSS, InDesign, fireworks and MYSQL database.

Progress

- In this reporting year, we have developed eighteen web and mobile-based fact sheets. And all fact sheets have been uploaded to the BRKB website.
- Updated with the latest information of Aman, Aus and Boro rice varieties included the latest variety of BRRI dhan108, BRRI dhan107, BRRI dhan106 and BRRI Hybrid dhan8 (Fig. 42).
- All types of information i.e., soil and fertilizer management, insects and rice diseases management etc. also updated regularly. It is routine work.
- A total number of 4,83,645 users have been visited the website.

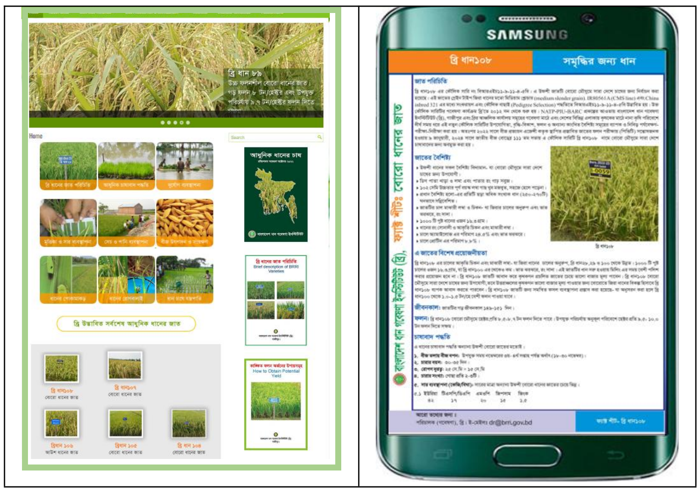


Fig.42: BRKB Website and mobile based fact sheet

Activity 7.11: BRRI Web Portal Management

- Nuraiya Kulsom, Md. Ismail Hossain, S.M. Mostafizur Rahman, Md. Mahfuz Bin Wahab, Mrs. Kabita, Md. Asadullah, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

The National Portal Framework (NPF) is the single platform for accessing all public information from any government organization to ensure easy accessibility for citizens. Counting all ministries, departments, semi-government and autonomous organizations and all government offices at the division, district, upazila and union levels there are about 27,000 government offices.

Objectives

1. To develop and modify the design of BRRI Web Portal.
2. To manage and maintain BRRI Web Portal through regular updating of the information and documents.

Methodology

BRRI web portal (www.brri.gov.bd) has been developed by ICT cell, Agricultural statistics division with help of Access to Information (a2i) Programme. BRRI has been incorporated with it as a first organization among the NARS institute. It is a citizen-oriented web portal so the large majority of the population including farmers, researchers, extension officers, students, and teachers are benefited from BRRI Web Portal.

Progress

- In this reporting year, updated more than 1580 (one thousand five hundred and eighty) pages and uploaded more than 6994 (six thousand nine hundred and ninety-four) documents like PDF, JPG, report, Word and other files on the BRRI website (Fig. 43).
- In the reporting year, sent sixteen website reports to the ministry of agriculture (MoA).
- BRRI has made the web portal in both Bengali and English languages. It is the largest web portal (www.portal.gov.bd) in the world and BRRI is incorporated with it as the first organization among the NARS institute.
- Developed Glory and Success of 50 years, BRRI writer's pool, Rice pest corner and many more.
- Included the rice database, climate database, Bangladesh Agriculture at a Glance etc. on BRRI dynamic website and updated it regularly.
- To make it more updated and informative, we developed individual web page including picture of Headquarter and all regional stations of BRRI.

Fig. 43: BRRI Web Portal

Activity 7.12: BRRI networks update, maintenance and extension

-Md. Mahfuz Bin Wahab, Md. Ismail Hossain, S. M. Mostafizur Rahman, Mrs. Kabita, Rokib Ahmed, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Facebook group is a page created for an organization or business to promote activities. Users can join the group and post their thoughts on a wall and interact through discussion threads. Groups, however, have the ability to message their members, as well as restrict who can and cannot join. *BRRI Networks* is a Facebook group, where only official interactions, various problems and their solutions can be post. It's a big forum for all kinds of scientists, officers and staffs of BRRI. ICT Cell created this Facebook to post anything for noble work of rice and rice related activity of this forum.

Objectives

- To create a group for BRRI to promote all activities of BRRI.
- To make a Facebook group, where only official interactions, various problems and their solutions can be post.
- To create a big forum for scientists, officers and staffs of BRRI. Where can post anything for noble work of rice and rice related activity of this forum.

Methodology

Basically, Facebook Groups are pages that you create within the Facebook social networking site that are based around a real-life interest or group or to declare an affiliation or association with people and things. The Facebook group of *BRRI Networks* link is (https://www.facebook.com/groups/1409267722690061/). Thus, the *BRRI Networks* is continuing with regular updating by posted everybody of this group.

Progress

- To build a linkage among all scientists, officers and staffs, where *BRRI Networks* (Fig. 44) play an important role.
- *BRRI Networks* group is regular updated by skilled ICT cell employee and to protect all types of unwanted post, photo and other's spam through online filtering.

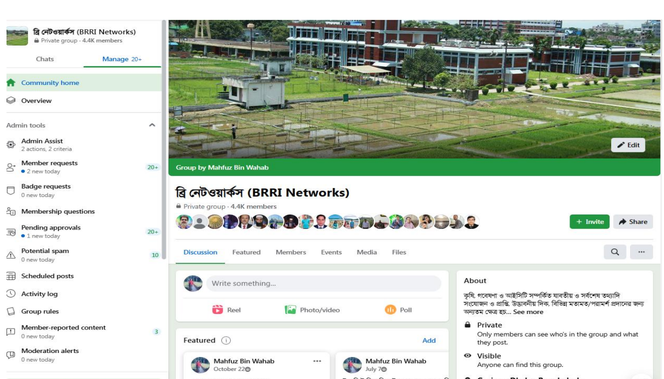


Fig. 44: BRRI Networks Facebook group

Activity 7.13: Personal Data Sheet database of BRRI

-Mrs. Kabita, Md. Ismail Hossain, S. M. Mostafizur Rahman, Md. Mahfuz Bin Wahab, Md. Asadullah, Nuraiya Kulsom, Md. Aminuzzaman, Md. Akhter Hossain

Introduction

Personal Data Sheet (PDS) is a document used by someone with a visual impairment or other impairment that inhibits his or her ability to read or write using a standard print format. The PDS contains all of the information that you would typically be asked to supply to complete an application. It includes name, address, telephone number, details about your academic and work history, supervisor's names, reference names and contact information etc. On the PDS, it can include everything; try to anticipate any question that might pop up on an application. ICT cell of Agricultural Statistics division provides user ID and Password and also approve data of PDS database.

Objectives

1. To develop PDS database for all scientists, officers of BRRI.
2. To develop PDS database using user name & password.
3. To get BACKUP of PDS database regularly.

Methodology

PDS is a convenient way of organizing all the information that will be required to complete an application form. Instead of trying to keep track of a number of documents (record of work history, references, address book, etc.), it is helpful to keep this important information all together on a few stapled pages. Everyone needs a personal data sheet. Each document is used for a different purpose.

Progress

- Version 5 of PDS has been developed (Fig.45).
- All data of Version 1 has been transferred to Version 5.
- PDS database is updated regularly with latest information. It is a routine work.

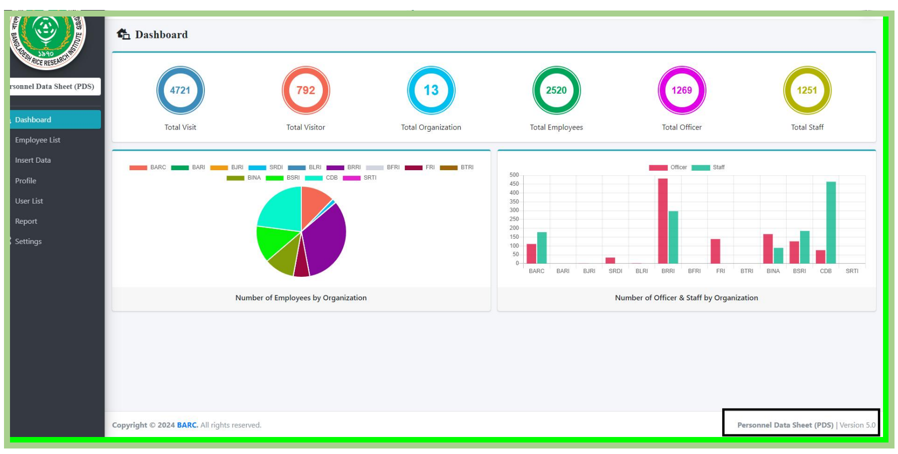


Fig.45: PDS Database of BRRI

Support Services and ICT related fair

The scientists of this division are also engaged in helping scientists of other disciplines in planning experiments, statistical data analysis and interpretation of results. Sixty different types of analyses were performed during the reporting period. A number of maps were prepared using GIS and supplied to the scientists of other divisions whenever required. Overall, ICT Cell of Agricultural Statistics division is providing D-Nothi system related support services to all research division, administration and procurement section. It is also providing BRRI heritage related support services such as updating data and uploading information to other divisions. Though it is an initiative in government perspectives but *BRRI Networks* facebook group and facebook page is a first introduced amongst all National Agricultural Research System (NARS) and also first among all research institute. It is regularly monitoring and updating with new information from any national and international newspaper or other sources. It is continuous process. Otherwise, ICT Cell of Agricultural Statistics division is providing hardware, network and internet related support services to other divisions such as setup antivirus software, clean virus, update antivirus database and various troubleshooting related problem etc. ICT Cell of Agricultural Statistics Division has been participated in several ICT and related fairs such as Digital World Fair, Development Fair, Tatha Mela and World Food Fair etc.