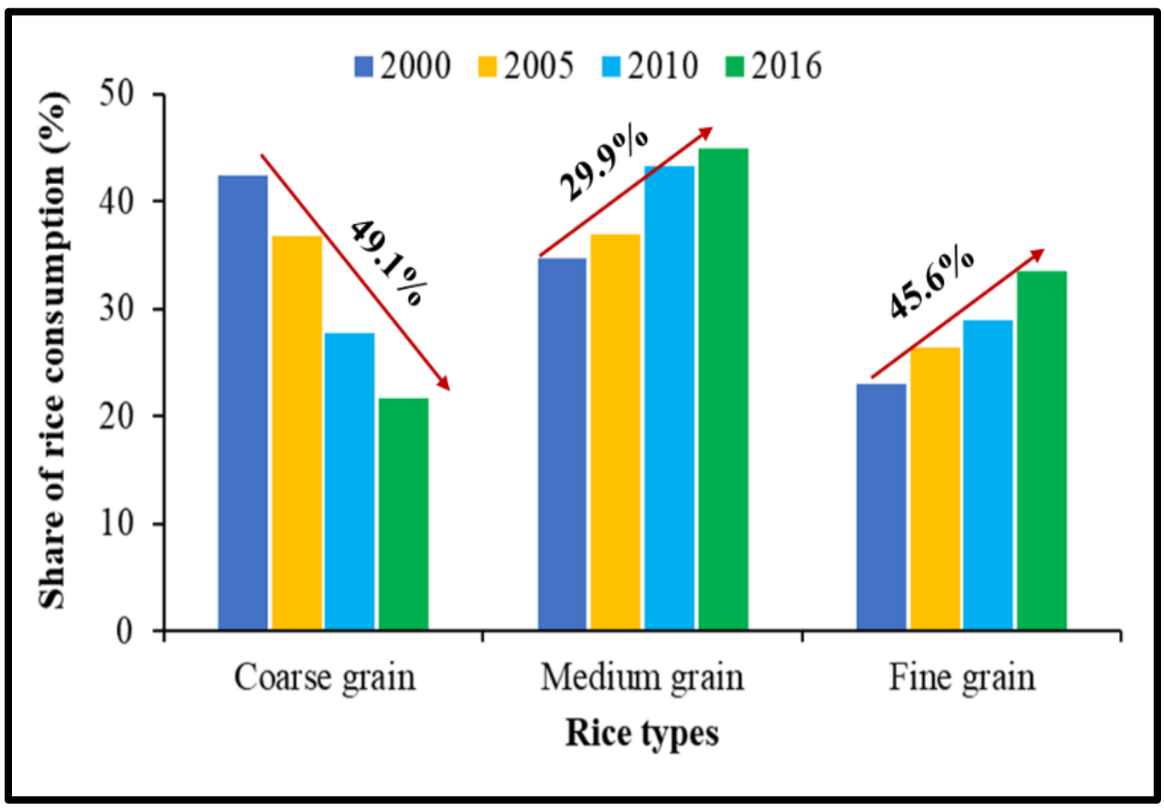
ANNUAL RESEARCH REVIEW WORKSHOP

2021-2022



XV. AGRICULTURAL ECONOMICS DIVISION

Bangladesh Rice Research Institute (BRRI)

Gazipur-1701

AGRICULTURAL ECONOMICS DIVISION

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CONTENTS

SUMMARY

Overall adoption of modern variety was 93.27, 88.02, and 99.52 percent in the Aus, T. Aman, and Boro seasons, respectively, with BRRI varieties covering around 74.48, 55.18, and 61.76 percent. It is worth value to note that there is a widespread dispute over the depletion of water resources, which is mostly caused by Boro agriculture utilizing underground water. The government introduced incentives and various subsidy schemes for Aus production to solve this problem, encouraging farmers to cultivate more Aus rice. With a greater incentive distribution, BRRI dhan48 placed first (49.41 percent) in the Aus season in terms of area coverage, followed by BRRI dhan28 (6.7 percent). Indian varieties covered about 20.11 percent areas in the T. Aman season. The Boro season's most adopted varieties were BRRI dhan28 and BRRI dhan29, which covered 41.25 percent of the area. In the Aus season, BRRI dhan82 produced the maximum yield (4.33 ton/ha), whereas, in the T. Aman and Boro seasons, it was BRRI dhan87 (4.72 ton/ha) and BRRI dhan92 (6.69 ton/ha), respectively. In the Boro season, Hybrids produced 7.27 tons per hectare on average.

One study aimed to examine the economic viability of aromatic rice cultivars in the study region, as well as assess the input use pattern and identify factors that influence the adoption of aromatic rice cultivars. The farmers in Naogaon (Tk. 1,69,917.5/ha) had greater gross returns than the farmers in the Jashore area (Tk. 1,65,099/ha). Similarly, the average net return per hectare is Tk. 43753.75; thus, farmers in the Nagaon district have a larger net return than those in Jashore. And the average BCR was 1.35, meaning if farmers invest 1 Tk, they get a return of 1.35 Tk. This implies that the cultivation of aromatic rice is profitable. On the other hand, probit marginal effects results showed that education, ln farm size, price difference, market demand, eating quality, extension service, and credit are all positive and significant means increasing uses of these factors would boost in the adoption of more aromatic cultivars in the study region. While the adoption of aromatic cultivars is severely impacted by occupation-only farming and yield differences.

Rice cultivation in the wetlands of the northeastern part of Bangladesh, known as *haor* areas, have accounted for one-fifth of the total rice production in the country. However, *haor* areas have been bearing the brunt of climate change since many decades. About 91% and 96% farmers of *haor* areas from Netrokona and Sunamganj district, respectively, believe that they have perception about climate change in their areas. A notable percentage of respondent farmers of both the areas mentioned that events like temperature, intensity of day time heat, unpredicted rainfall, changes of monsoon season, occurrences of drought, long summer season etc. has been increased in their respective areas over the last 20 years. Typically, long duration rice varieties in those areas face the loss from flash flood but this year, almost all of the cultivated variety got affected by the early flash flood as it occurred in the late March when the crop was in booting to ripening stage. However, farmers in both the study areas who were able to harvest at full, got rice farming as a profitable endeavor as the BCR were good by both cash and full cost basis. Shifting of harvesting maturity, early transplanting, taking loan, migration etc. were identified as major adaptation strategies for last few years whereas lack of money, land and information were being reported as main constraints in those studied *haor* areas. Fewer number of marketing intermediaries were observed in those areas which makes the marketing channel relatively shorter than other areas of the country.

Another study examined the adoption status, profitability and factors affecting the adoption decision of climate-resilient rice cultivars in the salinity-affected area. According to the findings, almost 9.25% of the dry season area in the study region was planted with salt-tolerant rice cultivars, while the remaining area was cultivated with other types. The average rice yield of the saline-tolerant variety was 3.95 t/ha, which was lower than other cultivars (4.18 t/ha). The profitability analysis revealed that cultivating other cultivars was comparatively more profitable than the salinity-tolerant rice cultivars. The BCR of salinity-tolerant rice cultivars was 1.12, and 1.18 for other cultivars. Additionally, the econometric model results indicated that the rice cultivation experience, scholling year, ln farm size, market demand, eating quality, training, extension service,

participation in the field demonstration program, membership of any agricultural organization, and the severity of salinity had a statistically significant effect on adoption decision of climate resilient rice cultivars.

Farmers used hired labor mainly on contractual basis for the three major labor-intensive intercultural operations of transplanting, harvesting, and carrying. The highest number of human labor (116 man-days/ha) was used for MV Boro cultivation. Farmers used more seed than the BRRI recommended rate (25 to 30 kg/ha). Fertilizer cost of Boro (Tk. 15,963/ha) and T. Aman rice (Tk 8,863 /ha) was higher than that of Aus (Tk 7,132/ha) rice cultivation. Irrigation cost of Boro season in the study year was a bit higher than the previous year because of a considerable increase in fuel price. The per hectare yield of Boro paddy (6,539 kg) was higher, followed by T. Aman rice (4,622 kg) and T. Aus rice (4,223 kg). Per hectare, the gross margin of rice cultivation in the T. Aman season (Tk. 64,650) was higher, followed by Boro (Tk. 54,573) and T. Aus season (Tk. 34,064). Similarly, per hectare net returns for T. Aman (Tk. 32,391) was higher, followed by Boro (Tk. 18,182) and Aus paddy (Tk. 3,338). Overall, rice cultivation was profitable at the current year due to the higher yield and market price. The gross profit ratio is 30, 31 and 44 for Boro, Aus and T. Aman, respectively. A high-profit ratio is an indication that the farmers are selling their produce at a high-profit level.

Good quality seed alone can increase rice yield by 15-20%. The study was conducted in Jashore district taking 60 seed growers evenly from the contract and non-contract growers of both Aman and Boro seasons. In Boro season, contract growers (CGs) used 27 kg seed per hectare while non-CGs used 28 kg per hectare on average. In Aman season, contract growers (CGs) used 27 kg seed per hectare while non-CGs used 33 kg per hectare on average. Non contract growers used more seed than the contract growers. Total cost of contract growers and non-contract growers was Tk 2,05,237/ha and Tk 2,07,054/ha respectively in Boro season while in T.Aman season it was Tk 1,94,965/ha and Tk 1,80,018/ha respectively. In Boro season, per kg cost of rice seed production was Tk 30.33 for CGs and 29.93 Tk for non-CGs while it was Tk 34.54 for CGs and Tk 32.27 for non-CGs in T. Aman season.

Rice price always remains at the center of controversy in Bangladesh. Major 12 spatially separated wholesale rice markets are found as co-integrated during 2012 to 2020. Mainly bidirectional causal relationships have been observed among those markets but in few cases unidirectional causal relationships have been evident which are not in line with the surplus, deficit and/or central characteristics of those markets under study. Moreover, poor price transmission, high and persistent volatilities have been identified among 12 major wholesale rice markets in the country. All these findings highlight the inevitability of public interventions in the rice market of Bangladesh.

The findings showed that, value chain operation in general was lengthy and involved more actors. Farmers mostly market their products with the help of *Bepari* and *Arardar*. Price of paddy was set in the midstream of rice value chains and storing paddy for short time was the only practice to get a good price at farm level. Local rice millers reported a common use of service from third party to sort, whiten and polish rice grain for acquiring the expected grain qualities which had higher market demand. Furthermore, lesser evidence of transformation in rice value chain was found at downstream where a single trading company was controlling wholesale market alone. The resilience of the rice value chain was found financed by the actors themselves. Farmers referred to price and bio-physical disruptions in farming as the most vulnerable aspects while traders and millers referred to financing and changes in pricing policies. Farmers coped adversities of rice cultivation by accumulating resources from non-rice and non-farm sectors. On the other hand, traders and millers coped with losses by increasing the rice price of the following years.

One more study aimed to figure out the market share and concentration of existing popular rice brands in Bangladesh. In the Upazila level markets, BR28 is the most popular rice brand contributing about 40% of the available rice, followed by Minikit (17.7%), Swarna (14.5%), and BR29 (12.1%). Whereas, in the city markets the share of Minikit is the highest (33.5%), followed by BR28 (19.4%), Zira (19.2%), and Nazir (8.5%). The traders are highly concentrated to produce the top 4 rice brands without exercising any competition in the market.

Another study aimed to investigate whether the export potential aromatic rice variety i.e. BRRI dhan50 has the comparative advantage in producing and exporting in the short run for the *Boro* (dry) season and to review international standards for rice export and way-out the link to the export policy. With that view, we estimated "Domestic Resource Cost (DRC)" as an indicator of comparative advantage using the cross-sectional data. Results show that, in an import parity situation, DRC values were 0.65 and 0.73, respectively, when head rice recovery was 56 and 52%. It means Bangladesh has a comparative advantage for producing export potential aromatic rice (BRRI dhan50) at import substitution. On the other hand, in the export parity situation, DRC values were 0.91 and 1.06, respectively, when head rice recovery was 56 and 52%. This implies that Bangladesh has a comparative advantage in exporting the potential aromatic rice like BRRI dhan50 at export substitution with head rice recovery at 56%. When head rice recovery has 52% and below, BRRI dhan50 does not have a comparative advantage at export substitution. Finally, after considering the minimum international standard of traits, BRRI dhan50 could not compete with aromatic rice trade commercially. It may compete only on government-to-government (G2G) contract.

PROGRAM AREA-I: RURAL INSTITUTION & ECONOMIC CONSEQUENCES

STUDY 1: FARM LEVEL ADOPTION AND EVALUATION OF MODERN RICE CULTIVATION IN BANGLADESH

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Introduction

Rice is the staple food in Bangladesh, which provides about 55 and 75% of the total protein and calories of the daily human diet (Siddique et al., 2016). About 75% of the total cropped area is devoted to rice cultivation in the country (BBS 2021). Bangladesh Rice Research Institute has developed 101 high-yielding modern varieties (MVs) along with seven hybrids for different production environments, which made an outstanding contribution towards the attainment of rice self-sufficiency in Bangladesh. The adoption rate of the cultivated modern varieties (MVs) differs substantially in different regions and seasons in Bangladesh. The study has been designed to verify the adoption status and performance of different rice varieties with the following specific objectives;

- to determine the region-wise adoption rate of rice varieties in different seasons; and
- to assess the yield of diverse rice varieties in different regions and seasons.

Methodology

Secondary data has been collected from 14 agricultural regions of Bangladesh. We collected Aus and Aman, seasons adoption data of 64 districts during 2021-2022 directly from the Additional Director's (AD) office of the Department of Agricultural Extension (DAE) (see figure 1 for details). Finally, we compiled the data, and simple tabular and descriptive statistics were used to analyze it.

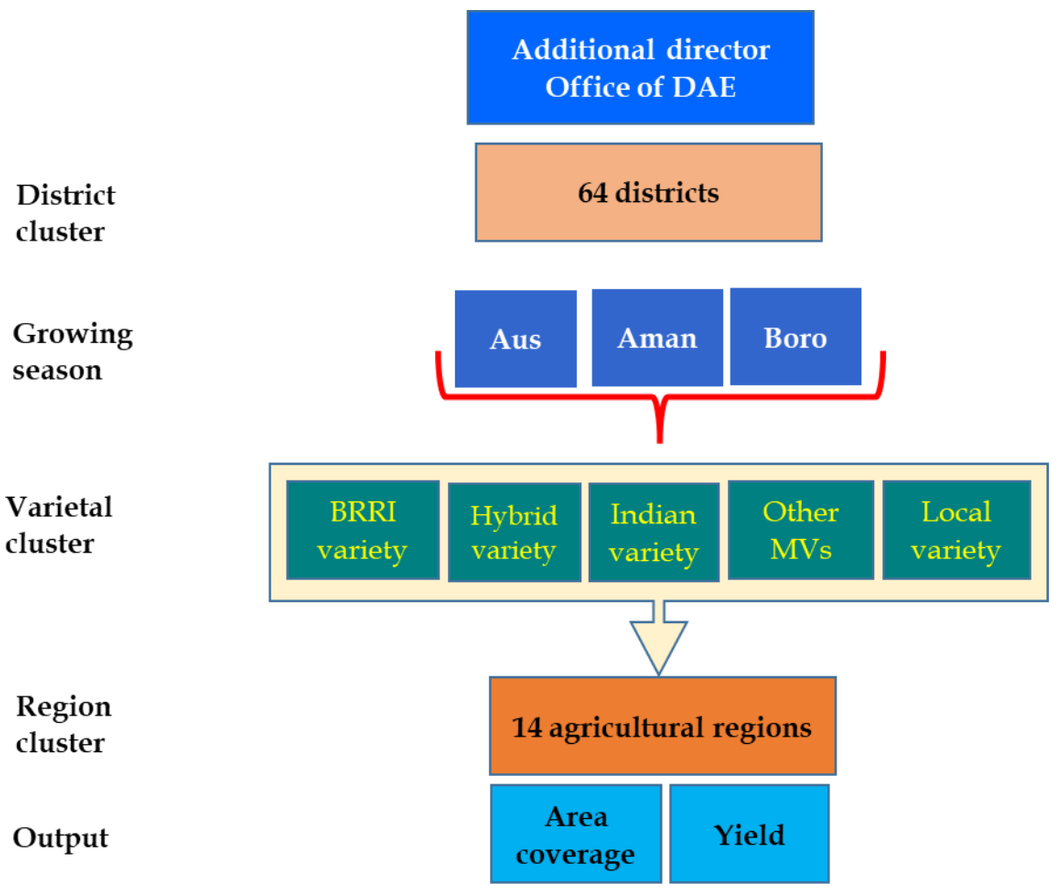

Figure 1. Methodology of the study

Results and discussion

Aus Season

The overall adoption rate of modern varieties in Aus season was about 93.27%, of which the coverage of BRRI developed varieties was about 74.48% in 2021-22. Adoption of BRRI varieties increased more than 0.55% from the previous year as it was 73.93% in 2020-21. In the Faridpur region (R7), BRRI varieties adoption was about 55.95%, whereas it was about 48.27% in 2020-21. Among all BRRI varieties, BRRI dhan48 ranked the top position (49.14%) in terms of area coverage, followed by BRRI dhan28 (6.70%) and BR26 (3.34%). Other MVs, Indian, and hybrids coverage in the Aus season were about 9.59%, 2.92%, and 5.01%, respectively. Results also revealed that area coverage of traditional varieties was about 6.73% in this season (Table 1).

T. Aman season

Overall adoption of modern varieties (MVs) in T. Aman season was about 88.02%, which was recorded as 86.93% in the previous year. Adoption of BRRI varieties' was 55.18%, which was also a bit higher than the last year (52.81%). Although adoption of BRRI varieties seemed low, it was substantially higher in some regions like Cumilla, Dhaka, and Sylhet, where the adoption of BRRI varieties was about 85.55, 71.33, and 83.7%, respectively. Adoption of BRRI varieties has notably increased in the Rajshahi region and covered 40.25% areas, while it was documented as 37.26% in the previous year (2020-21). BRRI dhan49 covered the highest area in T. Aman season in Bangladesh. It covered about 14.59% of the total areas. Coverage of BRRI dhan49 in some regions like Dhaka (47.54%), Mymensingh (33.36%), Sylhet (23.10%), and Cumilla (21.15%) was notable. However, the coverage of BR11 was about 4.11% of the total T. Aman areas. Adoption of this variety is decreasing but still popular in Rangamati (15.58%), Rangpur (9.42%), and Sylhet (8.07%) regions. Adoption of BRRI dhan34 was only about 3.25% of the total T. Aman areas. However, this variety occupied a comparatively larger area in Dinajpur (18.72%), Rajshahi (6.56%), and Mymensingh (4.36%) regions. On average, Indian varieties covered 20.11% of areas in T. Aman season. Notably, the adoption of Indian varieties mostly in border regions like Rangpur, Dinajpur, Bogura, Rajshahi, and Jashore was relatively high (36 to 54% of total areas). In comparison, Area coverage of local rice varieties in the Aman season was 11.98%. Adoption of local rice varieties substantially decreased from the previous year (13.61%) (Table 2).

Boro season

The adoption of modern rice varieties (MVs) in 2021-22 was about 99.52% of total Boro areas, of which 61.76% of areas were covered by BRRI varieties. BRRI dhan28 and BRRI dhan29 were the mega varieties in this season. The area coverage of the two varieties was about 41.25% in 2020-21, whereas those two varieties together adoption was about 62% in the year 2016-17. The adoption of those two varieties has been decreasing gradually due to disease (Blast) susceptibility. Besides, adoption of BRRI dhan58 was notable in the regions of Cumilla (17.09% of total areas), Rangamati (11.78% of total areas), Faridpur (10.71% of total areas), and Dinajpur (10.36% of total areas). Recently released among BRRI varieties, BRRI dhan74 has become a popular one in the Barishal region (17.80% of total boro areas). On the other hand, the overall adoption of hybrid and Indian varieties were about 24.72% and 5.44%, respectively. Nevertheless, adoption of Indian varieties was quite location-specific; for instance, adoption of the Indian variety was the highest in Rajshahi (54.79%) followed by Bogura (8.59%) and Dinajpur (7.94%) regions which include most of the rice growing border areas of the country (Table 3).

Table 1. Adoption (%) of different Aus rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BR1		0.01										0.1		0.13	0.02
BR2	3.15			4.2	0.3				2.02						0.95
BR20	0.53			8.13										0.15	0.79
BR21	0.03	3.81			0.1						2.48			1.75	0.76
BR26	3.03	4.31		2.53	3.37	0.24	3.38	3.59	5.04	7.56	1.25	1.83	0.86	8.28	3.34
BRRI dhan27	9.06	1.56	6.83	0.23			3.35		1.62			0.01		0.97	2.52
BRRI dhan28	**0.02**	**7.37**	**1.41**	**11.67**	**6.29**	**32.35**	**1.04**	**3.68**	**2.54**	**3.13**	**11.43**	**0.38**	**11.43**	**8.34**	**6.7**
BRRI dhan33	0.08		0.06	0.34	0.2							0.69	0.18	0.05	0.08
BRRI dhan42	0.88	0.31	3.07	0.11		0.23	2.03				0.08	0.8	1.16	1.67	0.84
BRRI dhan43	1.11		2	1.97	0.04	0.24	7.25	0.01		0.27		1.53	0.26	1.43	0.96
BRRI dhan48	**46.71**	**53.11**	**46.44**	**45.4**	**78.02**	**29.34**	**26.26**	**53.82**	**24.49**	**79.63**	**45.31**	**4.59**	**48.12**	**61.99**	**49.41**
BRRI dhan55	1.6	1.81	16.16	2.89	0.65	1.47	5.44	0.74	3.21	0.25	2.04	1.88	0.31	3.1	3.18
BRRI dhan65	0.1	0.79	0.09		0.1		2.64				0.1	0.32	0.33	0.36	0.21
BRRI dhan82	1.05	2.58	1.14	1.4	1.69	2.56	2.29	1.55	1.78	2.04	0.39	0.53	2.07	2.18	1.48
Other BRRI Varieties	2.17	0.71	1.66	6.37	2.71	5.47	1.69	2.17	1.84	1.81	0.72	1.37	5.87	4.18	2.8
BRRI Varieties total	**69.55**	**76.36**	**78.87**	**85.26**	**93.48**	**71.9**	**55.95**	**65.56**	**42.53**	**95.23**	**66.81**	**14.52**	**70.66**	**94.58**	**74.48**
BRRI Hybrids	0.1	0.01			0.24		0.05		0.05						0.03
Hybrids total	**0.18**	**1.03**	**4.38**	**10.19**	**1.17**	**24.32**	**0.1**	**6.55**	**6.63**		**3.23**	**0.27**	**26.53**	**0.04**	**5.01**
Zira sail		2.57				0.01		0.37			13.98				2.01
Indian varieties total		**3.25**		**0.1**		**1.06**		**6.95**			**13.98**				**2.92**
BINA varieties total	**0.87**	**1.92**	**0.66**	**0.68**	**0.99**	**1.54**	**3.49**	**0.91**	**1.47**	**4.05**	**0.6**	**0.79**	**2.23**	**2.01**	**1.26**
Nerika		0.41		0.01		0.23	0.21							0.11	0.05
Parija		0.69				0.66					10.06				1.38
Others MVs	22.69	1.75	5.59	3.56	0.08	0.16		18.34	9.77	0.25	3.94	0.86	0.58	1.34	8.16
Other MVs total	**22.7**	**2.85**	**5.59**	**3.58**	**0.08**	**1.05**	**0.21**	**18.34**	**9.77**	**0.25**	**14.01**	**0.86**	**0.58**	**1.45**	**9.59**
All MVs total	**93.29**	**85.41**	**89.5**	**99.81**	**95.74**	**99.87**	**59.74**	**98.31**	**60.4**	**99.53**	**98.62**	**16.43**	**99.99**	**98.07**	**93.27**
All LVs total	**6.71**	**14.59**	**10.5**	**0.19**	**4.26**	**0.13**	**40.26**	**1.69**	**39.6**	**0.47**	**1.38**	**83.57**	**0.01**	**1.93**	**6.73**
Grand total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Districts covered by the regions:

Region 1 (Barishal): Barishal, Patuakhali, Barguna, Jhalokhati, Pirojpur and Bhola;
Region 2 (Bogura): Bogura, Sirajganj, Joypurhat and Pabna;
Region 3 (Chattogram): Feni, Noakhali, Cox's Bazar, Laxmipur and Chattogram;
Region 4 (Cumilla): Cumilla, B.Baria, and Chandpur;
Region 5 (Dhaka): Dhaka, Tangail, Manikganj, Narshingdi, Narayanganj, Munshiganj, Gazipur, and Kishoreganj;
Region 6 (Dinajpur): Dinajpur, Panchagarh and Thakurgaon;
Region 7 (Faridpur): Rajbari, Gopalganj, Shariotpur, Madaripur and Faridpur;
Region 8 (Jashore): Kushtia, Meherpur, Chuadanga, Jashore, Jhenaidah, and Magura;
Region 9 (Khulna): Khulna, Satkhira, Narail and Bagerhat;
Region 10 (Mymensingh): Jamalpur, Mymensingh, Sherpur and Netrakona ;
Region 11 (Rajshahi): Rajshahi, C.Nawabganj, Naogaon, and Natore;
Region 12 (Rangamati): Khagrachari, Bandarban and Rangamati;
Region 13 (Rangpur): Rangpur, Kurigram, Lalmonirhat, Gaibandha and Nilphamari;
Region 14 (Sylhet): Habiganj, Sylhet, Moulvibazar and Sunamganj.

Table 2. Adoption (%) of different T. Aman rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BR11	**9.28**	**2.17**	**3.75**	**1.07**	**1.43**	**0.21**	**1.58**	**0.35**	**2.86**	**2.11**	**0.08**	**15.58**	**9.42**	**8.07**	**4.11**
BR22	**4.64**	**2.13**	**8.15**	**32.45**	**7.38**		**0.08**	**0.17**	**3.49**	**2.92**		**1.53**	**0.06**	**9.2**	**4.36**
BR23	10.68	0.11	5.88	5.37	0.2		0.13	0.17	11.47	0.7	0.01	0.01	0.46	2.21	3.08
BRRI dhan30	0.06		0.12		0.14			0.25	5.74		0.03	0.06		0.02	0.36
BRRI dhan32	0.18	0.21	1.51	5.83	1.64		0.07		0.01	4.66	0.02	0.93	0.04	2.72	1.21
BRRI dhan33	0.03	1.14	1.47	0.06	0.09		11.11	2.35	0.66	0.06	0.68	5.06	0.72	0.08	0.95
BRRI dhan34	0.12	5.14	0.01	1.32	0.77	18.72	0.27	0.25	0.21	4.36	6.56	0.2	1.51	0.91	3.25
BRRI dhan39	0.02	2.79	1.46	1.64	0.31		18.15	4.37	2.03	0.68	1.51	4.53	0.58	1.16	1.75
BRRI dhan40	1.04	0.01	3.24	0.03	0.02		0.13		0.02	0.03		2.11	0.09	0.23	0.52
BRRI dhan41	1.25	0.11	1.79	0.42	0.12		0.11		0.36	0.31		1.58	0.15	0.71	0.51
BRRI dhan44	1.91		0.44	0.11			0.11					0.38	0.01	0.16	0.31
BRRI dhan46	0.14		1.17	5.95	0.16	0.03	0.07			0.17		1.13		1.78	0.54
BRRI dhan49	**2.05**	**16.8**	**15.79**	**21.15**	**47.54**	**3.35**	**9.25**	**10.4**	**10.46**	**33.36**	**7.11**	**18.54**	**4.06**	**23.1**	**14.59**
BRRI dhan51	**1.01**	**3.32**	**3.32**	**0.59**	**3.41**	**7.58**	**2.81**	**7.96**	**0.76**	**3.75**	**18.12**	**2.28**	**3.86**	**24.21**	**6.49**
BRRI dhan52	**13.77**	**2.26**	**11.49**		**2.14**	**1.76**	**3.72**	**1.21**	**4.06**	**4.62**	**0.56**	**3.3**	**9.43**	**4.47**	**5.66**
BRRI dhan56	0.04	0.38			0.08	0.1	0.52	0.09	0.01	0.04	0.16	1.11	0.65	0.1	0.17
BRRI dhan57	0.09	0.38	0.04			0.12	0.47	0.23		0.03	0.01	0.12	0.06		0.09
BRRI dhan62	0.07	0.32		0.11	0.07	0.24	0.47	0.81	0.2	0.05	0.05	0.01	0.15	0.1	0.18
BRRI dhan71	0.18	0.43	0.51	0.13	0.6	0.04	0.41	2.04	0.46	1.59	0.9	3.65	0.87	0.42	0.73
BRRI dhan75	0.07	1.47	1.34	1.45	0.85	0.5	6.89	5.57	2.56	0.34	1.57	2.06	1.04	1	1.51
BRRI dhan87	0.08	1.4	1.68	5.6	2.87	0.42	4.47	8.16	3.03	0.87	2.06	0.1	1.32	1.19	2.06
Other BRRI varieties	4.55	1.45	2.55	1.92	1.45	0.7	1.94	2.16	14.93	0.73	0.81	4.28	1.48	1.82	2.63
BRRI varieties total	**51.27**	**42.08**	**65.74**	**85.55**	**71.33**	**33.74**	**62.85**	**46.6**	**64.12**	**61.57**	**40.25**	**68.73**	**36.32**	**83.7**	**55.18**
BRRI Hybrids	0.01	0.01		0.02	0.03		0.26	0.02	0.11	0.05			0.05	0.02	0.03
Other Hybrids	0.09	5.28	1.97	1.94	4.64	8.94	6.57	8.67	5.9	11.09	1.02	1.94	9.82	0.07	5.12
Hybrids total	**0.1**	**5.29**	**1.97**	**1.96**	**4.68**	**8.94**	**6.83**	**8.69**	**6**	**11.14**	**1.02**	**1.93**	**9.88**	**0.09**	**5.15**
Guti Swarna	**3.39**	**24.84**		**0.79**	**0.78**	**38.48**	**1.3**	**27.5**	**3.26**		**40.56**		**38.91**	**1.36**	**14.88**
Ronjit		8.31	0.13		2.13	1.38		0.07		0.94	0.73		2.24	1.61	1.32
Other Swarna varieties		3.28	8.28	0.57		13.63		2.01		1.08	1.09	2.61	6.91		3.37
Other Indian varieties		0.15			0.26	0.47		1.2	0.01	2.19	2.26				0.54
Indian varieties total	**3.39**	**36.58**	**8.41**	**1.37**	**3.17**	**53.96**	**1.3**	**30.78**	**3.27**	**4.21**	**44.64**	**2.61**	**48.05**	**2.97**	**20.11**
Bina dhan-7	0.21	4.97	0.44	2.31	1.86	0.43	9.64	6.28	2.38	2.05	3.37	0.04	1.29	2.16	2.28
Bina dhan-11	0.08	0.04	0.1	0.22	0.89	0.01	1.02	0.08	0.23	0.58	0.02	1.14	0.7	0.45	0.31
Bina dhan-17	0.17	2.64	0.18	0.6	0.48	0.39	5.82	3	0.85	0.18	1.22	1.29	0.95	0.95	1.04
Other BINA varieties	0.31	0.41	0.06	0.38	0.15	0.04	0.31	0.34	0.39	0.12	0.07	2.35	0.15	0.08	0.16
BINA varieties total	**0.77**	**8.05**	**0.79**	**3.51**	**3.38**	**0.87**	**16.78**	**9.7**	**3.85**	**2.93**	**4.69**	**4.83**	**3.08**	**3.64**	**3.84**
Hori dhan	1.06		2.86		0.46					2.5	0.01	3.79	0.05		0.74
Pajam		0.9	7.25	0.29	6.44					3.74	0.77	4.05	0.01	0.06	1.6
Others MVs	0.97	6.45	0.21			1.89	0.31	3.5	3.13	0.15	0.51	9.63	0.45	0.26	1.39
Other MVs total	**2.04**	**7.35**	**10.33**	**0.29**	**6.9**	**1.89**	**0.31**	**3.5**	**3.13**	**6.39**	**1.29**	**17.47**	**0.59**	**0.32**	**3.75**
All MVs Total	**57.57**	**99.36**	**87.23**	**92.68**	**89.45**	**99.4**	**88.08**	**99.27**	**80.38**	**86.23**	**91.9**	**95.57**	**97.92**	**90.72**	**88.02**
All LVs Total	**42.43**	**0.64**	**12.77**	**7.32**	**10.55**	**0.6**	**11.92**	**0.73**	**19.62**	**13.77**	**8.1**	**4.43**	**2.08**	**9.28**	**11.98**
Grand Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Table 3. Adoption (%) of different Boro rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BR14	0.03		0.61		0.53					0.17			3.46	0.75	0.55
BR16	0.01	0.75	2.51	1.81		4.70	0.08			0.08		0.78	2.36	0.02	0.84
BR26	0.02		0.28	0.02	0.16		0.05	0.29	0.59	1.66		0.15		0.21	0.34
BRRI dhan28	**6.80**	**14.48**	**14.10**	**23.09**	**23.15**	**16.42**	**8.42**	**15.11**	**22.12**	**24.74**	**12.99**	**12.35**	**18.25**	**26.78**	**19.02**
BRRI dhan29	**5.57**	**22.56**	**8.57**	**29.21**	**51.69**	**26.77**	**32.16**	**1.51**	**1.02**	**28.49**	**6.83**	**5.92**	**12.74**	**28.36**	**22.23**
BRRI dhan47	10.02		0.84	0.15			0.50		0.04			0.14	0.04	0.01	0.42
BRRI dhan50	0.29	0.41	0.65	0.62	0.53	0.96	1.83	14.20	2.48	0.10	0.46	0.57	0.71	0.59	1.69
BRRI dhan58	1.18	6.83	6.83	17.09	7.09	10.36	10.71	7.81	4.05	8.32	2.48	11.78	8.53	7.11	7.73
BRRI dhan63	0.01	0.36	0.24	0.70	0.21	0.41	0.68	9.83	1.46	0.18	0.29	0.28	0.32	0.30	1.09
BRRI dhan67	2.95	0.05	3.19	0.56	0.22	0.19	1.04	0.28	4.27	0.66	0.01	0.85	0.05	0.42	0.76
BRRI dhan74	17.80	1.04	4.43	2.57	0.50	1.73	2.21	0.97	1.38	1.16	0.09	5.06	4.71	1.03	2.25
BRRI dhan81	0.09	1.55	0.47	0.82	0.50	1.57	0.58	3.94	1.46	0.44	3.69	0.47	1.87	0.73	1.37
BRRI dhan84	0.05	0.19	0.44	0.37	0.08	0.80	0.04	0.34	0.30	0.22	0.12	0.49	0.47	0.66	0.32
BRRI dhan88	0.07	0.28	0.27	0.54	0.19	0.25	0.07	0.19	0.68	0.45	0.03	0.41	0.31	0.75	0.34
BRRI dhan89	0.71	1.08	0.64	1.16	0.74	0.68	0.54	0.21	0.49	0.79	0.08	0.54	0.71	0.99	0.71
BRRI dhan92		0.02	0.10	0.22	0.02	0.02	0.02	0.05	0.02	0.01	0.01	0.08	0.20	0.18	0.07
Other BRRI varieties	2.75	2.50	9.09	4.26	0.10	0.36	2.18	1.22	0.41	0.77	1.48	7.42	1.89	2.84	2.05
BRRI varieties total	**48.34**	**52.09**	**53.26**	**83.19**	**85.70**	**65.20**	**61.11**	**55.94**	**40.76**	**68.24**	**28.57**	**47.31**	**56.62**	**71.73**	**61.76**
ACI	3.15	0.47	2.70	0.81	0.83	3.23	2.48	0.65	3.58	1.33	0.43	4.43	3.85	0.18	1.58
Hira	6.15	1.42	15.21	3.89	2.24	2.64	4.21	1.43	9.94	5.19	1.44	11.32	8.43	6.02	4.91
Janakraj	0.56	0.02	0.40	0.15	0.44	0.83	0.20		1.40	1.56	0.03	2.16	2.69	5.20	1.24
SL-8H	5.06	1.51	5.33	4.36	2.72	0.79	13.15	4.44	9.37	2.99	1.00	5.49	3.55	2.87	3.68
Tej Gold		0.57		0.92	0.83	0.68		1.81	3.42	5.15		1.60	1.56		1.43
Other hybrids	21.18	4.40	17.91	6.23	6.71	10.47	15.02	5.80	26.26	14.95	3.70	25.13	20.90	11.66	11.88
Hybrids total	**36.10**	**8.38**	**41.55**	**16.36**	**13.77**	**18.63**	**35.05**	**14.12**	**53.97**	**31.16**	**6.60**	**50.14**	**40.97**	**25.93**	**24.72**
Sampa Katari						4.30					2.89				0.45
Zira		8.57				3.17		1.10			51.69		0.19		4.93
Other Indian varieties		0.02				0.47		0.32	0.01		0.21				0.07
Indian varieties total		**8.59**				**7.94**		**1.41**	**0.01**		**54.79**		**0.19**		**5.44**
BINA varieties total	**6.55**	**0.27**	**1.47**	**0.39**	**0.06**	**0.01**	**0.98**	**0.83**	**2.38**	**0.13**	**0.08**	**2.29**	**0.30**	**0.69**	**0.71**
Other MVs total	**7.00**	**29.90**	**3.44**	**0.03**		**8.22**	**1.48**	**27.70**	**2.78**	**0.35**	**9.95**	**0.27**	**1.57**		**6.89**
All MVs total	**97.98**	**99.23**	**99.73**	**99.96**	**99.53**	**100**	**98.62**	**100**	**99.90**	**99.88**	**100**	**100**	**99.65**	**98.34**	**99.52**
All LVs total	**2.02**	**0.77**	**0.27**	**0.04**	**0.47**	**0.00**	**1.38**		**0.10**	**0.12**			**0.35**	**1.66**	**0.48**
Grand Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Yield of modern rice varieties

Tables 4, 5 and 6 present per hectare yield of modern rice varieties in different seasons and regions of Bangladesh.

Aus season

In Aus season, the average yield of BRRI varieties was about 4.12 ton/ha; among them, BRRI dhan82 produced the highest yield (4.33 ton/ha) and BRRI dhan48 and, BRRI dhan28 ranked the second and third position with an average yield of 4.29, and 4.15 ton/ha, respectively. The yield performance of the hybrid varieties was also higher (5.48 ton/ha) compared to Indian varieties (4.22 ton/ha) in this season. The average yield of all MVs in the Aus season was 4.49 ton/ha (Table 4).

Table 4. Average yield (t/ha) of different Aus rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BR1		3.79										3.42		3.93	3.77
BR2	3.74			3.81	3.37				3.93						3.70
BR20	4.17			4.17										3.17	3.83
BR21	3.94	3.96			3.03						3.92			3.73	3.77
BR26	3.93	3.83		4.17	3.86	4.59	3.75	4.26	4.06	3.88	4.27	3.80	3.65	3.81	3.96
BRRI dhan27	4.00	3.48	4.03	4.25			3.70		4.12			3.64		3.86	3.96
BRRI dhan28	3.33	3.95	4.89	4.16	4.14	4.06	3.69	4.58	3.95	3.98	4.71	4.05	4.04	3.88	4.15
BRRI dhan33	3.94		4.60	4.09	3.79							3.94	4.10	4.15	4.09
BRRI dhan42	3.54	4.60	4.10	4.27		4.02	3.79				2.66	3.95	3.62	3.57	3.81
BRRI dhan43	3.71		3.99	4.15	3.64	3.98	3.68	4.85		4.00		3.89	3.58	3.69	3.86
BRRI dhan48	**4.10**	**4.22**	**4.16**	**4.55**	**4.43**	**4.11**	**3.86**	**4.75**	**4.18**	**4.12**	**4.96**	**3.71**	**4.39**	**4.15**	**4.29**
BRRI dhan55	3.79	4.08	4.06	4.43	4.21	4.55	3.71	4.71	4.11	4.33	4.63	4.24	3.84	3.88	4.13
BRRI dhan65	3.87	4.14	4.39	4.04	3.83		3.69	4.85			4.58	3.98	3.74	3.53	3.97
BRRI dhan82	**4.13**	**4.31**	**4.01**	**4.28**	**4.45**	**4.85**	**3.82**	**4.69**	**4.13**	**4.27**	**4.99**	**4.31**	**4.14**	**4.19**	**4.33**
Other BRRI varieties	4.02	4.12	4.15	4.24	4.34	4.70	3.79	4.51	4.17	4.34	4.59	3.94	4.27	3.85	4.19
BRRI varieties total	**3.93**	**4.08**	**4.17**	**4.23**	**4.17**	**4.40**	**3.76**	**4.57**	**4.10**	**4.15**	**4.56**	**3.99**	**4.04**	**3.84**	**4.12**
BRRI Hybrids total	7.18	4.55			5.29		4.92		5.61					5.68	5.38
Hybrids total	5.48	4.63	5.48	5.54	5.55	5.47	5.08	5.64	5.04		5.61	5.45	5.60	5.51	5.48
Zira sail		3.57				3.79		4.24			4.31				4.05
Indian varieties total		3.77		4.11		4.13		4.39			4.31				4.22
BINA varieties total	4.05	3.99	3.92	4.29	4.34	4.89	4.23	4.29	4.07	4.02	4.31	4.49	3.93	3.62	4.16
Nerika	4.09	2.60		3.79		4.18	3.84	3.94						3.84	3.67
Parija		3.64				4.24					3.92				3.93
Others MVs	3.82	3.68	4.07	3.84	4.70	4.66		4.55	3.54	3.74	4.37	4.33	3.86	4.90	4.06
Other MVs total	3.84	3.37	4.07	3.83	4.70	4.36	3.84	4.49	3.54	3.74	4.24	4.33	3.86	4.37	4.00
All MVs total	**4.06**	**4.05**	**4.44**	**4.70**	**4.43**	**5.04**	**3.98**	**4.97**	**4.44**	**4.09**	**4.74**	**4.11**	**4.90**	**3.98**	**4.49**
All LVs Total	2.13	2.24	2.12	1.94	2.22	2.72	2.00	1.89	1.95	2.23	2.48	2.17	3.03	2.11	2.13
Grand Total	**3.59**	**3.87**	**3.87**	**4.49**	**4.16**	**4.97**	**3.30**	**4.68**	**3.94**	**3.81**	**4.46**	**3.11**	**4.89**	**3.58**	**4.07**

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

T. Aman Season

Among BRRI varieties, BRRI dhan87 was the top yielder (4.72 ton/ha), followed by BRRI dhan75 (4.57 ton/ha), BRRI dhan52 (4.55 ton/ha), BRRI dhan49 (4.53 ton/ha), and BRRI dhan51 (4.51 ton/ha) in T. Aman season. On the other hand, the average yield of BINA varieties, hybrids, and Indian varieties were 4.39, 5.71, and 4.47 ton/ha, respectively. The average yield of BRRI varieties was about 4.39 tons/ha. Overall yield of modern varieties (MVs) in T. Aman season was 4.69 tons/ha (Table 5).

Table 5. Average yield (t/ha) of different T. Aman rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BR11	4.16	4.31	4.50	4.08	4.34	5.06	4.38	5.09	4.34	4.23	4.12	4.41	4.42	4.19	4.39
BR22	3.98	4.38	4.48	4.22	4.20		4.38	4.81	4.38	4.24		4.20	4.08	4.13	4.26
BR23	4.07	4.22	4.42	4.17	4.15		4.04	4.58	4.25	4.19	3.86	5.30	3.93	4.16	4.20
BRRI dhan30	3.94		4.55		4.29			4.53	4.25		4.88	4.24		4.08	4.30
BRRI dhan32	3.93	4.18	4.36	4.16	4.16		4.20		3.61	4.25	4.37	4.20	3.79	4.02	4.15
BRRI dhan33	3.90	4.49	4.19	4.09	4.45		4.41	4.55	4.51	4.19	4.44	4.45	3.86	4.29	4.29
BRRI dhan34	3.75	3.59	4.20	3.99	3.59	3.39	3.50	4.01	4.23	3.88	3.52	4.44	3.55	3.88	3.76
BRRI dhan39	3.79	4.23	4.42	4.14	3.92		4.49	4.66	4.19	4.46	4.61	4.41	4.06	3.90	4.27
BRRI dhan40	3.89	4.24	4.42	4.00	4.45		4.36		5.18	4.37		4.27	4.09	4.14	4.25
BRRI dhan41	3.95	4.31	4.41	4.15	4.43		4.32		4.61	4.18	4.39	4.02	3.96	4.08	4.20
BRRI dhan44	4.04		4.77	4.32			4.77					4.80	4.09	4.02	4.29
BRRI dhan46	4.02		4.40	4.12	4.36	4.79	4.17			4.12		4.65		4.09	4.28
BRRI dhan49	**4.06**	**4.45**	**4.59**	**4.52**	**4.60**	**4.61**	**4.56**	**4.94**	**4.31**	**4.53**	**5.10**	**4.56**	**4.27**	**4.38**	**4.53**
BRRI dhan51	4.19	4.47	4.59	4.37	4.34	4.73	4.62	4.93	4.44	4.40	5.47	4.44	4.23	4.13	4.51
BRRI dhan52	**4.30**	**4.48**	**4.65**		**4.44**	**4.51**	**4.72**	**4.77**	**4.48**	**4.44**	**5.23**	**4.77**	**4.40**	**4.13**	**4.55**
BRRI dhan56	4.10	4.71			4.26	4.30	4.63	4.78	4.45	4.21	4.77	4.23	4.13	4.02	4.38
BRRI dhan57	4.24	4.27	3.82		3.67	4.34	4.61	4.59	4.36	4.38	4.55	4.70	4.10		4.27
BRRI dhan62	3.77	4.19		4.24	4.48	4.16	4.37	4.72	4.34	4.14	4.31	4.24	3.82	4.02	4.22
BRRI dhan71	3.74	4.40	4.47	4.42	4.33	4.51	4.52	4.99	4.41	4.28	4.67	4.70	4.32	4.36	4.42
BRRI dhan75	**4.34**	**4.71**	**4.50**	**4.47**	**4.48**	**4.79**	**4.50**	**4.99**	**4.59**	**4.30**	**4.98**	**4.45**	**4.48**	**4.31**	**4.57**
BRRI dhan87	**4.21**	**4.86**	**4.65**	**4.69**	**4.80**	**4.87**	**4.58**	**5.29**	**4.54**	**4.24**	**5.15**	**4.37**	**4.42**	**4.94**	**4.72**
Other BRRI varieties	4.18	4.59	4.36	4.39	4.41	4.65	4.50	4.89	4.50	4.27	4.73	4.47	4.36	4.38	4.46
BRRI varieties total	**4.08**	**4.45**	**4.42**	**4.29**	**4.36**	**4.53**	**4.44**	**4.85**	**4.44**	**4.26**	**4.70**	**4.46**	**4.20**	**4.23**	**4.39**
BRRI Hybrids	5.45	6.12	6.06	6.01	5.95		5.87	6.48	5.68	5.45	6.36		5.11	5.96	5.81
Other Hybrids	5.51	5.77	6.03	5.74	5.71	5.73	6.12	6.09	5.66	5.59	6.45	6.21	5.23	5.98	5.76
Hybrids total	5.47	5.75	6.09	5.71	5.71	5.61	6.05	6.03	5.76	5.64	6.46	6.25	5.20	6.00	5.71
Guti Swarna	4.05	4.58		4.24	4.25	4.89	4.18	4.80	4.13		5.26		4.48	4.09	4.50
Ronjit		4.64	4.41		4.20	4.50		4.82		4.29	4.47		4.33	3.90	4.39
Other Swarna varieties		4.55	4.46	4.27		4.76		4.88		3.98		4.14	4.24		4.47
Other Indian varieties		4.33			4.38	4.56		4.66	4.09	4.26	4.76				4.46
Indian varieties total	**4.05**	**4.52**	**4.45**	**4.26**	**4.26**	**4.71**	**4.18**	**4.77**	**4.12**	**4.19**	**4.87**	**4.14**	**4.36**	**4.00**	**4.47**
Bina dhan-7	3.94	4.36	4.58	4.36	4.23	4.40	4.46	4.81	4.20	4.09	4.45	3.18	4.05	4.13	4.29
Bina dhan-11	4.00	4.38	4.33	4.32	3.96	4.41	4.48	5.10	4.47	4.21	4.69	4.37	4.11	4.26	4.33
Bina dhan-17	3.58	4.43	4.30	4.07	4.49	4.55	4.69	5.22	4.35	4.17	4.95	4.55	4.70	4.31	4.49
Other BINA varieties	3.79	4.55	3.99	4.24		5.30	4.59	5.10	4.37	3.42	4.82	4.18	4.22	4.65	4.36
BINA varieties total	3.96	4.50	4.30	4.26	4.37	4.56	4.54	5.04	4.34	4.10	4.79	4.27	4.26	4.25	4.39
Hori dhan	3.79		4.34		5.55					4.30	5.15	4.98	4.22		4.47
Pajam	3.79	3.78	4.23	3.95	3.47					3.71	4.09	4.33	4.47	3.64	3.89
Others MVs	4.21	4.40	4.29			4.58	4.47	4.61	4.30	3.86	4.48	4.19	4.16	4.17	4.40
Other MVs total	**4.11**	**4.27**	**4.29**	**3.95**	**4.16**	**4.56**	**4.47**	**4.61**	**4.30**	**3.97**	**4.47**	**4.35**	**4.21**	**3.90**	**4.31**
All MVs total	**4.13**	**4.76**	**4.74**	**4.59**	**4.60**	**4.96**	**4.89**	**5.15**	**4.68**	**4.63**	**4.94**	**4.58**	**4.63**	**4.43**	**4.69**
All LVs total	**2.46**	**2.20**	**2.56**	**2.36**	**2.54**	**2.83**	**2.70**	**2.57**	**2.62**	**2.53**	**2.68**	**2.50**	**2.41**	**2.26**	**2.51**
Grand Total	**3.35**	**4.50**	**4.17**	**4.05**	**4.06**	**4.79**	**4.28**	**4.93**	**4.04**	**3.97**	**4.71**	**4.28**	**4.27**	**3.84**	**4.17**

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Boro Season

In the Boro season, the average yield of BRRI varieties in 2021-22 was about 6.00 ton/ha. Among BRRI varieties, BRRI dhan92 was the top yielder (6.69 ton/ha), followed by BRRIdhan89 (6.59 ton/ha), BRRI dhan29 (6.41 ton/ha), and BR16 (6.36 ton/ha). The average yield of the hybrid was 7.27 ton/ha (Table 6). At the same time, the average yield of Indian varieties was 5.92 tons/ha. The overall yield of modern varieties in Boro season was about 6.61 ton/ha.

Table 6. Average yield (t/ha) of different Boro rice varieties by agricultural regions of Bangladesh, 2021-22.

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BRRI popular	5.71	5.82	5.76	6.17	6.07	6.56	6.46	6.10	5.77	5.93	6.78	5.86	6.03	5.83	6.04
BR14	5.62		5.80		5.66					5.45			4.66	5.57	5.36
BR16	5.56	6.67	7.65	5.80	5.30	6.64	6.57			5.32		5.62	5.73	5.83	6.36
BR26	5.77		7.10	5.31	5.88		6.59	5.51	0.51	5.59		5.64		5.74	5.56
BRRI dhan28	5.53	6.42	5.50	5.72	5.30	6.25	6.17	5.94	5.94	5.74	6.54	5.53	5.80	5.55	5.81
BRRI dhan29	**5.79**	**6.85**	**5.80**	**6.50**	**6.34**	**6.83**	**6.66**	**6.61**	**6.27**	**6.32**	**7.03**	**6.03**	**6.69**	**6.27**	**6.41**
BRRI dhan47	5.56		4.18	6.48			6.29		5.45			5.56	5.84	5.84	5.41
BRRI dhan50	5.52	6.30	5.20	5.74	5.71	6.22	5.93	6.20	5.80	5.50	6.17	5.63	5.73	5.19	5.77
BRRI dhan58	5.76	6.45	5.75	6.28	6.25	6.64	6.55	6.63	5.92	5.97	6.85	5.83	6.14	5.75	6.20
BRRI dhan63	5.30	0.00	4.12	5.85	5.90	6.28	6.33	6.43	5.92	5.72	6.54	5.74	5.81	4.52	5.37
BRRI dhan67	5.52	0.00	5.67	6.02	5.76	6.60	6.26	6.18	5.81	6.01	6.56	5.76	5.46	5.60	5.77
BRRI dhan74	5.93	6.52	5.80	6.29	6.02	6.51	6.50	5.20	5.80	6.18	6.61	5.97	6.24	5.77	6.05
BRRI dhan81	5.71	6.63	5.77	6.05	5.84	7.07	6.48	6.44	5.87	5.75	7.69	5.77	5.88	5.85	6.17
BRRI dhan84	6.05	6.51	6.10	6.26	5.98	6.92	6.36	4.90	5.98	5.50	6.52	6.14	6.04	5.81	5.96
BRRI dhan88	5.68	6.37	5.82	6.24	6.20	4.70	6.53	6.32	5.97	6.21	6.66	5.82	6.42	6.03	6.11
BRRI dhan89	**6.05**	**6.66**	**5.98**	**6.55**	**6.80**	**7.58**	**6.89**	**6.44**	**5.92**	**6.74**	**6.99**	**6.49**	**6.64**	**6.97**	**6.59**
BRRI dhan92		**6.52**	**6.13**	**6.92**	**7.11**	**7.35**	**6.94**	**6.32**	**5.65**	**6.37**	**7.09**	**6.37**	**6.68**	**6.91**	**6.69**
Other BRRI varieties	**5.75**	**6.10**	**5.61**	**5.90**	**5.97**	**6.33**	**6.59**	**6.17**	**5.91**	**5.93**	**6.39**	**5.72**	**5.75**	**5.69**	**5.92**
BRRI Varieties total	**5.72**	**5.91**	**5.71**	**6.07**	**6.06**	**6.49**	**6.49**	**6.12**	**5.78**	**5.93**	**6.70**	**5.80**	**5.94**	**5.78**	**6.00**
ACI	6.10	7.77	8.70	7.17	7.30	7.04	7.91	6.26	7.35	7.33	8.00	6.97	7.40	7.22	7.25
Hira	7.19	7.84	7.17	7.27	7.33	6.20	7.90	7.43	7.35	7.43	8.09	7.17	7.32	7.21	7.36
Janakraj	8.38	7.58	12.79	7.34	7.58	7.61	8.18		7.38	7.35	7.95	7.10	7.45	7.14	8.12
SL-8H	7.06	7.92	5.95	7.33	7.36	7.41	7.99	7.66	7.31	7.42	8.08	7.16	7.46	7.36	7.38
Tej Gold		7.72		7.25	7.46	7.13		8.09	6.90	7.21		6.81	7.34		7.33
Other hybrid total	7.35	7.51	6.98	6.99	7.23	7.23	7.63	6.85	6.87	7.36	8.09	7.07	7.23	7.04	7.23
Hybrids total	**7.27**	**7.57**	**7.22**	**7.06**	**7.26**	**7.20**	**7.69**	**6.95**	**6.93**	**7.36**	**8.08**	**7.06**	**7.25**	**7.07**	**7.27**
Sampa Katari						6.24					5.98				6.07
Zira		5.73				6.41		5.91			6.72		5.61		6.15
Other Indian varieties		**6.06**				**4.93**		**6.06**	**5.76**		**5.92**				**5.56**
Indian varieties total		**5.81**				**5.49**		**5.98**	**5.76**		**6.34**		**5.61**		**5.92**
BINA varieties total	**5.64**	**5.76**	**5.70**	**5.78**	**5.70**	**5.63**	**6.43**	**6.21**	**5.79**	**5.73**	**6.30**	**5.65**	**5.76**	**5.08**	**5.81**
Other MVs total	5.67	6.13	5.52	6.17		6.40	6.23	6.25	5.75	5.70	5.99	4.96	5.77	5.79	5.93
All MVs total	**6.51**	**6.68**	**6.37**	**6.48**	**6.56**	**6.80**	**7.02**	**6.46**	**6.49**	**6.72**	**7.14**	**6.39**	**6.71**	**6.38**	**6.61**
All LVs total	**2.72**	**2.18**	**3.03**	**2.55**	**2.83**		**2.88**		**2.97**	**2.95**	**4.34**		**2.33**	**2.71**	**2.76**
Grand total	6.31	6.48	6.34	6.30	6.10	6.80	6.65	6.46	6.42	6.41	7.12	6.39	6.61	5.87	6.42

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Trend changes in adoption and yield level

A comparative picture of overall changes in MV adoption and yield level is given in table 7. The overall adoption of modern varieties in the Aus season increased from 17.30% in 1990-91 to 93.27% in 2021-22, resulting in a 75.97% increase in Aus season MV rice adoption. On the other hand, in T. Aman season MV adoption also increased from 29.28% in 1990-91 to 88.02% in 2021-22. The changes in adoption of the modern T. Aman variety was 58.74 % in 2021-22. In Boro season, the adoption of modern rice varieties increased from 88.93 % in 1990-91 to 99.52% in 2021-22. Also yield increased in 2021-22 about 71.09, 43.52, and 66.92% compared to 1990-91 in the Aus, T. Aman and Boro seasons, respectively. It might be due to good management practices and the adoption of high yield potential BRRI developed rice varieties.

Table 7. Adoption rate, production, clean rice yield, and growth rate of modern rice varieties over the years.

Season/Items	Period		Differences
	1990-91*	2021-22	
Aus:			
Adoption (%)	17.30	93.27	75.97
Production (%)	27.91	96.57	68.66
Yield (t/ha)	1.73	2.96	1.23 (71.09)
T. Aman:			
Adoption (%)	29.28	88.02	58.74
Production (%)	41.78	93.57	51.79
Yield (t/ha)	2.16	3.10	0.94 (43.52)
Boro:			
Adoption (%)	88.93	99.52	10.59
Production (%)	93.60	99.79	6.13
Yield (t/ha)	2.63	4.39	1.76 (66.92)

Source: BBS, '*' means national average. The figure in the parentheses indicate the percent

Conclusion

Overall adoption of modern variety was 93.27, 88.02, and 99.52 percent in the Aus, T. Aman, and Boro seasons, respectively, with BRRI varieties covering around 74.48, 55.18, and 61.76 percent. It is worth value to note that there is a widespread dispute over the depletion of water resources, which is mostly caused by Boro rice cultivation using underground water. The government introduced incentives and various subsidy schemes for Aus production in order to solve this problem and encouraging farmers to bring more areas for Aus rice. BRRI dhan48 placed first (49.41 percent) in the Aus season in terms of area coverage, followed by BRRI dhan28 (6.7 percent). Indian varieties covered about 20.11 percent in the T. Aman season. In Boro season, most adopted varieties were BRRI dhan28 and BRRI dhan29, which covered 41.25 percent of the area. In the Aus season, BRRI dhan82 produced the maximum yield (4.33 ton/ha), whereas, in the T. Aman and Boro seasons, it was BRRI dhan87 (4.72 ton/ha) and BRRI dhan92 (6.69 ton/ha), respectively. In the Boro season, Hybrids produced 7.27 tons per hectare on average.

STUDY 2: DRIVERS INFLUENCING ADOPTION DECISION OF AROMATIC RICE IN SOME SELECTED AREAS OF BANGLADESH: AN ECONOMETRIC APPROACH

MS Rahaman, MC Rahman, MA Islam, MAR Sarkar and MS Islam

Introduction

In Bangladesh, Aman rice production is considered the most significant rice-growing season since this season is ideal for cultivating quality, aromatic, and premium rice with vast market demand. Aromatic fine rice is recommended to grow in the Aman season to get better quality (Mannan et al. 2012). Despite the generally favorable agro-climatic conditions, the area of aromatic rice is less than 2% of the national rice acreage of Bangladesh (Asrafuzzaman et al., 2009). Bangladesh has a stock of above 8,000 rice germplasms, of which nearly 100 are aromatic (Hamid et al. 1982; Khalequzzaman et al. 2012). The cultivation of fine as well as fragrant rice has been gaining popularity in Bangladesh over recent years (Das & Baqui, 2000). Growing demand in local and international markets with lucrative prices of high-yielding aromatic rice has recently encouraged farmers to increase their cultivation. As a result, the cultivation of aromatic rice in 2020-2021 increased up to 6% national rice acreage of Bangladesh in the Aman season.

Aromatic cultivars are grown throughout the country. More fragrant rice is produced in cooler regions. Many places in Bangladesh produce a lot of fragrant rice commercially, such as Dinajpur, Thakurgaon, Panchagarh, Rangpur, Naogaon, Jashore, Rajshahi Mymensingh, and Sherpur districts. Bangladesh has approximately 54 aromatic and fine grain rice types cultivated in various parts of the country, which is worth mentioning. Given the importance of scented rice, Bangladesh Rice Research Institute (BRRI) has released seven aromatic and premium quality rice cultivars, including the BR5, BRRI dhan34, BRRI dhan37, BRRI dhan38, BRRI dhan70, BRRI dhan80, and BRRI dhan90. Kalijira, Chinigura, Kataribhog, Chiniatob, and Tulshimala are indigenous fragrant varieties with thin grains and wonderful smells.

In Aman season, the aromatic rice cultivars are widely adopted in Jashore and Naogaon districts. Therefore, the current research was intended to get a more profound knowledge of the economic insights and drivers of the fragrant rice variety, with the following particular objectives.

(i) To assess the profitability of aromatic rice cultivars; and

(ii) To identify the factors influencing the adoption decision of aromatic rice varieties.

Methodology

Study area and Data

Both primary and secondary data were used for this study. Jashore and Naogaon districts were chosen purposively. One Upazila from each district was purposefully chosen. The survey was conducted in Sadar Upazila of Jashore and Mohadebpur in Naogaon district. A large portion of the selected Upazilas is known for growing fragrant rice.

A pre-tested structured questionnaire was used to conduct in-person interviews with 100 randomly chosen agricultural families, 50 of which came from each Upazila. Additionally, farmers acquired information on their views of seasonal changes in yield, price, and the patterns of input used for aromatic rice types.

Analytical technique

Profitability was calculated in terms of gross return, gross margin, net return, and the benefit-cost ratio (BCR).

Gross return: Gross return was calculated by multiplying the total volume of rice output with per unit price received by the farmers. It consisted of the sum of the volume of the main product and its by-product (Dillon and Hardaker, 1993).

Gross Return = Σ (Q x P)
Where Q = Quantity of the output; and P = Price of the output.

Gross margin:
The difference between total return and variable cost.
Gross Margin = Gross return − Total variable cost

Net return:
Net return was obtained by deducting all costs (variable and fixed) from gross return. ,
Net return, $\pi = \Sigma P_y Q_y - \Sigma (P_{xi} X_i) - TFC$.
Where, P_y = Per unit price-output; Q_y = Total quantity output; P_{xi} = Per unit price of i-th inputs; X_i = Quantity of the i-th inputs; TFC = Total fixed cost (Tk); and i = 1, 2, 3,....., n (number of inputs).

Benefit-cost ratio (BCR): The BCR is a relative measure used to compare benefit per cost unit. The BCR estimated as a ratio of gross returns and gross costs. The formula (undiscounted) for measuring BCR is shown below:
Benefit-cost ratio = Gross benefit / Gross cost

The econometric model

This study aimed to identify socioeconomic and demographic factors that affect farmers' decision to adopt fragrant rice varieties during the T. Aman season. Because a response model links the likelihood of an occurrence to several independent factors, it is ideal for the farmers' dichotomous character.To provide a detailed analysis of the adoption decision of aromatic rice, we applied a discrete choice probit model for binary responses (yes, no). The probit model is a statistical probability model with two categories in the dependent variable (Liao 1994). Probit analysis is based on the cumulative normal probability distribution. The binary dependent variable takes on the values of zero and one (Aldrich and Nelson 1984). Therefore, the probit analysis can provide statistically significant results to identify the factors that influence the farmers to cultivate/adopt aromatic rice cultivars in the Aman season.

In the binary probit model, farmers who cultivated/adopted aromatic cultivars were taken as 1, while those not cultivated/adopted as 0. The probability Pi of choosing any alternative over not choosing it can be expressed as in (1), where φ represents the cumulative distribution of a standard normal random variable (Greene 2011):

$$Pi = prob[Y_i = 1|X] = \int_{-\infty}^{x_i'\beta} (2\pi)^{-\frac{1}{2}} \exp\left(-\frac{t^2}{2}\right) dt \qquad (1)$$

$$Pi = \Phi\,(x_{i'}\,\beta) \qquad (2)$$

The relationship between a specific variable and the probability outcome is interpreted by means of the marginal effect, which accounts for the partial change in the probability. The marginal effect associated with continuous explanatory variables Xk on the probability $P(Y_i = 1 \mid X)$, holding the other variables constant, can be derived as follows (Greene, 2011):

$$\frac{\partial P_i}{\partial x_{ik}} = \phi(x_i'\beta)\beta_k \qquad (3)$$

where ϕ represents the probability density function of a standard normal variable. The marginal effect on dummy variables should be estimated differently from continuous variables. Discrete changes in the predicted probabilities constitute an alternative to the marginal effect when evaluating the influence of a dummy variable. Such an effect can be derived from the following (Greene 2011):

$$\Delta = \Phi(\bar{x}\beta, d = 1) - \Phi\,(\bar{x}\beta, d = 0) \qquad (4)$$

The marginal effects provide insights into how the explanatory variables shift the decision of cultivating/adopting aromatic rice cultivars. Using the econometric software, marginal effects were calculated for each variable.

Variable's definition

The socioeconomic, demographic, and financial factors those affect farmers' decisions to grow aromatic rice in the study area might differ. In this study, we make the assumption that farmers' adoption of aromatic cultivars was influenced by their socioeconomic and demographic traits. Farmers' age, education, occupation, family size, number of family members who engage in farming, farm size, price difference between aromatic and non-aromatic rice, market demand, eating quality, extension service, training, distance to UAO, distance to local market, credit, yield difference, and disease infestation were all taken into account as explanatory variables (Table 8).

Table 8. Socioeconomic variables and the pertinent descriptive statistics.

Variables	Definitions	Mean values
Dependent variable		
Adopting aromatic rice	1=Yes, 0=Otherwise	0.45
Independent variable		
Age	Years	45.02
Schooling	Years of schooling	6.5
Occupation	1= Only farming	0.45
Family size	Number	4.65
Family members involve in farming	Number	1.62
Farm size	Acre	1.3
Price difference	The average price difference between aromatic and other rice varieties perceived by farmers (tk/kg)	12.5
Market demand	1= Yes	0.79
Eating quality	Farmer perceives Eating quality of aromatic rice is good than other rice varieties (1 = agree, 0 = disagree)	0.70
Training	1= received training	0.29
Extension service	1= received extension service	0.53
Distance to UAO	Kilometer	9.89
Distance to local market	Kilomete	2.5
Credit	1= received	0.25
Yield difference	Kg/ha	0.55
Disease infestation	Farmer perceives disease infestation in aromatic varieties (1= higher than other varieties)	0.75

*****Total observation 100
Source: Analyzed and prepared by the authors based on the data from the field survey.

Results and discussion

Comparative input use pattern and profitability of aromatic rice variety in the study area

Figures 1 and 2 represent per hectare input used for aromatic rice cultivation in 2021-22 in study area. For the three main labor-intensive intercultural activities, such as transplanting, harvesting, and carrying, farmers often employ workers on a contractual basis. In contrast, post-harvest processing, weeding, applying fertilizer and pesticides, and land preparation were all done by employing workers at a daily wage. Additionally, farmers use the power thresher on a custom-hired basis to thresh rice

throughout the T. Aman season. An average of 102.5 labors/ha are needed for everything from planting paddy seeds through weeding, applying fertilizer and pesticides, harvesting, threshing, cleaning, drying, and storing paddy (Figure 1). Farmers used 31kg/ha of aromatic rice seed on average. Farmers of the Naogaon district usually had greater DAP application rates, and the Jashore district had higher TSP applications, whereas MoP application rates were similar (Figure 2).

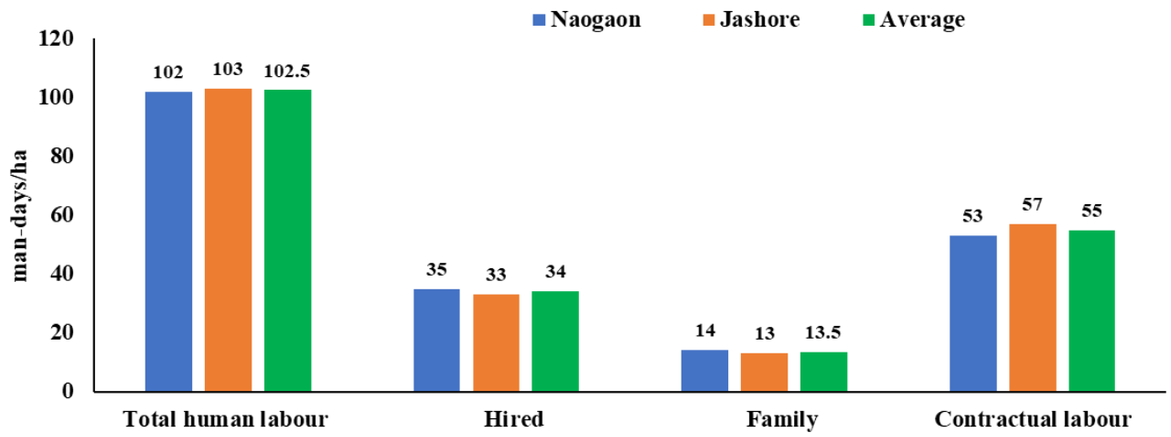

Figure 1. Per hectare labour used for aromatic rice cultivation. Source: Prepared by authors from survey data.

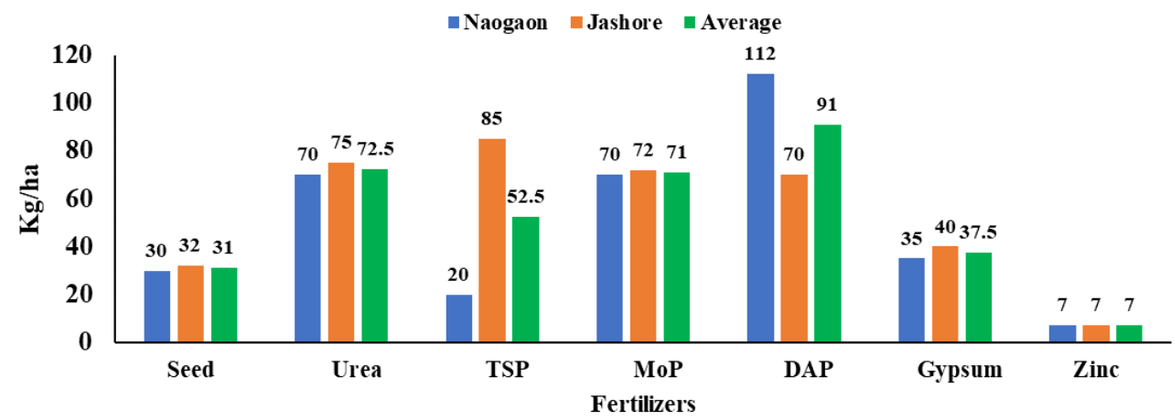

Figure 2. Per hectare seed rate and fertilizer application for cultivating aromatic rice. Source: Prepared by authors from survey data.

The average labor cost per hectare for aromatic rice in the study area was Tk. 46,125. Compared to farmers in the Jashore district (Tk 7,077/ha), farmers in the Naogaon district (Tk 6,194/ha) spent less on fertilizer for rice growing. The studied region's average variable cost for growing aromatic rice was Tk. 71,230/ha (Table 9).

The cost and return of producing fragrant rice per hectare in the Naogaon and Jashore districts are shown in Table 10. The production of aromatic rice is 3.239 tons per hectare on average; however, it is higher in the Jashore (3.293 ton/ha) than in the Naogaon (3.185 ton/ha) district. But compared to the farmers in the Jashore (Tk. 1,65,099/ha) district, the farmers in Naogaon (Tk. 1,69,917.5/ha) obtained higher gross returns. The price is high in Nagaon district because the demand for aromatic rice is higher, and many aromatic rice-producing mills are situated in the Naogaon district. The average net income is Tk. 43753.75/ha, where the net income of the Nagaon district farmers is higher than Jashore. Overall, findings show that growing fragrant rice is a lucrative business and a crucial source of income for rural farm communities.

Table 9. Per hectare cost of aromatic rice cultivation in 2021-22.

Cost items	Naogaon (TK./ha)	Jashore (TK./ha)	Average (TK./ha)
Seed	2610	2880	2745
Seedling development	2450	2250	2350
Land preparation (ploughing and laddering)	7500	7875	7687.5
Human labour:	45900	46350	46125
Hired	15750	14850	15300
Family	6300	5850	6075
Hired contract (transplanting, weeding and harvesting)	23850	25650	24750
Fertilizer cost	6194	7077	6635.5
Irrigation	0	0	0
Pesticide:	9300	9350	9325
Herbicide	675	850	762.5
Insecticide and fungicide	8625	8500	8562.5
Power thresher	2250	2625	2437.5
Total variable cost	69904	72557	71230.5
Interest on operating capital	1428	1470	1449
Land rent	45000	45000	45000
Total fixed cost	52728	52320	52524
Total Cost	122632	124877	123754.5

Source: Field Survey, 2021-22

Table 10. Per hectare profitability of aromatic rice cultivation in, 2021-22.

Sl. No.	Items	Naogaon	Jashore	Average
1	Total costs (TK./ha) (2+3)	122632	124877	123754.5
2	Total variable costs (TK./ha)	69904	72557	71230.5
3	Total fixed cost (TK./ha)	52728	52320	52524
4	Yield (kg/ha)	3185	3293	3239
5	Market value of paddy (TK./ha) (4*11)	144917.5	141599	143258.25
6	Market value of straw (TK./ha)	25000	23500	24250
7	Gross benefit (GB) (TK./ha) (5+6)	169917.5	165099	167508.25
8	Gross margin (GM) (TK./ha) (7-2)	100013.5	92542	96277.75
9	Gross profit ratio ((GM*100)/GB)	58.86	56.05	57.46
10	Net return (TK./ha) (7-1)	47285.5	40222	43753.75
11	Cost of production (TK./kg)	38.50	37.92	38.21
12	Selling price of grain (TK./kg)	45.5	43	44.25
13	BCR (cash cost basis) (7/2)	2.43	2.27	2.35
14	BCR (full cost basis) (7/1)	1.38	1.32	1.35

Source: Field Survey, 2021-22

Outcomes of the Probit model

Table 11 displays the estimated results from the binary probit models. The table shows the estimated coefficients and standard errors for the parameters that affected the farmers' choice to adopt or grow aromatic rice varieties. Multicollinearity and heteroscedasticity have no impact on choosing the right parameters, which checks off the dataset's diagnosis. The present model has a higher degree of overall significance, and the F value has always reflected the model's fitness level. The model's findings are consistent with some of the earlier research findings and imply that nine of the sixteen factors included in the model significantly impacted the choice to adopt/cultivate aromatic cultivars.

At a 5% significance level, the years of education variable was found positive and significant. As anticipated, this variable showed a positive and very significant result. Therefore, education has a significant impact on aromatic rice adoption. Recent investigations by authors like Phillips (1994),

Alene and Mangyong (2007), Abdulai and Huffman (2014), and Khonje, et al. (2015) provide support to this finding. In other words, a minimum level of education helps farmers acquire, understand and analyse information on new technology, thereby leading them to its adoption. The outcomes of marginal effect suggests that the probability of adopting aromatic rice cultivars would be increased by 3.5 percent in the study areas as one percent grew in farm size.

The findings demonstrate a clear relationship between the amount of farm holdings and the adoption of fragrant rice cultivars. Farmers' adoption of aromatic rice cultivars rose as the farm size increased, according to the significant and positive sign-on farm size. According to the marginal impact estimate, with every 1% increase in farm size, the likelihood of adopting aromatic rice cultivars will rise in the research regions by 5.28 percent. These results are consistent with Ghimire et al. (2015) and Danso-Abbeam et al. (2017).

The price of the paddy is always a bigger contributor to agricultural income. So, a major factor in the adoption of aromatic rice cultivars is the favorable and notable price differential that emerges between aromatic and other cultivars. The marginal impact calculation shows that a 1% rise in the price of paddy will increase the likelihood of adopting aromatic rice cultivars in the research regions by 6.39%. Rahaman et al. (2020) and Michler et al. (2019) found similar findings.

Another essential factor is market demand. The adoption of aromatic rice cultivars will rise by 13.77 percent in the study region as a result of a 1% increase in market demand, according to the model's positive and significant coefficients. Similar results were observed by Rahaman et al. 2020.

Additionally, positive and significant coefficients show that the choice to adopt more fragrant cultivars is strongly influenced by the quality and taste of the rice. According to the findings of the marginal impact, an improvement in rice's flavor and quality of one percent would boost the adoption of aromatic cultivars by 8.9 percent. The findings are compliant with those reported by Timu et al. (2014), Otieno et al. (2011), and Rahaman et al. (2020).

Table 11. Estimated results of Probit model for determinants of adoption of aromatic rice varieties

Variables	Coefficient	Robust standard error	Marginal Effect
Age	0.0132	0.0102	0.0193
Education	0.0290**	0.0130	0.035**
Occupation only farming	-0.0448**	0.0130	0.0686**
Family size	0.0035	0.0252	0.0027
Family members involve in farming	0.0037	0.0345	0.0032
Ln farm size	0.0656**	0.0299	0.0528**
Price difference	0.0792**	0.0321	0.0639**
Market demand	0.1505***	0.0577	0.1377***
Eating quality	0.1284**	0.0584	0.0893**
Training	0.0303	0.0452	0.0312
Extension service	0.1120***	0.0328	0.0921***
Distance to UAO	0.0632	0.2153	0.0567
Distance to local market	-0.0367	0.0300	0.0254
Credit	0.1182**	0.0543	0.1062**
Yield difference	-0.0921***	0.0297	0.0785***
Disease infestation	-0.0856	0.0769	0.0798
Constant	-0.8588	0.5366	
Log pseudo likelihood	-271.21		
Prob > F	0.000		
Pseudo R2	0.522		
Breush-pagan Heteroskdasticity			
chi2(1)	2.31		
Prob > chi2	0.1327		
Mean VIF	1.84		
Sample size	100		

** and *** indicates significance at the 5 and 1 percent levels.

The adoption of modern fragrant rice cultivars in the study area is heavily dependent on the DAE's agricultural extension program. The marginal impact findings show that a one percent increase in extension services in the study region will contribute to a 9.21 percent increase in the cultivation of aromatic rice. This result is consistent with the findings of Ghimire et al. (2015), Chandio and Yuansheng (2018), and Rahaman et al. (2020).

The introduction of aromatic cultivars has a beneficial and considerable impact on credit accessibility. The majority of the time, farmers utilize credit to buy the essential agricultural inputs they need, such as better and certified varieties, fertilizers, insecticides, and farm equipment. Farmers in Bangladesh have additional opportunities to adopt new rice varieties due to official and informal finance sources. According to the marginal effects, a one percent increase in loan availability would contribute to a 10.62 percent rise in the adoption of aromatic rice in the studied area. This finding is similar to the Tiamiyu et al. (2009), Chekene and Chancellor (2015), and Hagos and Zemedu (2015).

On the other hand, only farming and the yield difference coefficient were found significant but negative. Most farmers who grow rice as their only source of income do not want to accept new varieties or rice cultivars with lower yields. The leading cause of this is because they consider how they would feed their family with the lower produce. Since meeting their fundamental needs is a top concern. According to the findings, a 1% increase in farming as the sole profession would cause a 6.8% and 7.8% decline in the adoption of aromatic rice cultivars in the research region, respectively.

Conclusion

This research investigates the profitability of aromatic rice cultivars, the pattern of input use, and the factor that affects fragrant rice cultivar's adoption in the designated study area. According to the profitability analysis, the output of aromatic rice is 3239 kg per hectare. The farmers in Naogaon had greater gross returns (Tk. 1,69,917.5/ha) than the farmers in the Jashore area (Tk. 1,65,099/ha). Similarly, the average net return per hectare is Tk. 43753.75; thus, farmers in the Nagaon district have a larger net return than those in Jashore. The probit econometric model was used to identify the determinants of adoption. The empirical marginal effects results showed that education, farm size, price difference, market demand, eating quality, extension service, and credit are all positive and significant means increasing uses of these factors would boost the adoption of aromatic cultivars at a higher rate in the research regions. The adoption of aromatic cultivars is severely affected by occupation: only farming and yield differences.

Based on the research findings, it is suggested that government and non-government organizations strengthen their extension services, monitor market prices and maintain price stability, increase credit availability, develop high yielding disease-resistant aromatic cultivars, maintain low input prices, and ensure the availability of verified seed to help farmers to produce more aromatic rice. Additionally, certain areas must be selected in order to boost the sector and supply the necessary resources to the local farmers. This will improve the production of fragrant rice. In order to lower cultivation costs and raising profit margins, a set of crop production methods and post-harvest technologies suitable for aromatic rice will be needed.

STUDY 3: UNDERSTANDING CLIMATE VARIABILITY, ADAPTATION AND MARKET INSIGHTS OF RICE IN *HAOR* ECOSYSTEMS

L Deb, SMMH Noman, SA Jui, A Chowdhury and MS Islam

Introduction

Bangladesh is characterized by agro-zones that are highly susceptible to drought, cyclones, flooding, and rising salinity, rendering Bangladesh one of the most vulnerable countries in the world to climate change. Changing courses of the river systems and frequent monsoon flooding in Bangladesh gives a diverse wetland, such as rivers, *baors* (resulting from loss of river flows), *beels* and *haors* (natural depressions), and flood lands. The *haor* basin in the Northeastern zone of Bangladesh is an important wetland ecosystem. A total of about 0.71 million ha of net cultivable land is available in haor area, which produces more than 5.25 million tons of paddy each year. Since *haor* goes under flooding (5-10 m) from late May to October, almost 80% of this area is covered by Boro rice, while only about 10% area is covered by T. Aman. Flood, especially flash flood causes severe damage to Boro rice just before harvesting almost every year. Therefore, this study has been designed to fulfill the following objectives:

- to dig out the understandings of farmers about climate change;
- to investigate the dynamics of losses and adaptation practices; and
- to inspect the marketing systems of rice in the studied areas.

Methodology

Farm level data were collected from Khaliajuri and Mohongonj upazila of Netrokona district and Tahirpur and Sadar upazila of Sunamganj district during June 2022. Purposive sampling technique was applied to collect the data from 40 farmers and 10 traders from each upazila by structured questionnaire. Thus, the total sample size was 200 for the study where the total number of farmers and traders were 160 and 40, respectively. Besides, expert opinions were collected from respective extension personnel.

Analytical Techniques and Model

Activity Budgets

To determine per hectare profitability for each of the selected paddy farming from the view point of individual farmers, the following algebraic equation will be followed:

$$\Pi = \sum Q_y.P_y + \sum Q_b.P_b + \sum_{i=1}^{n}(X_i P_{xi}) - TFC$$

Where,

$\prod$= Net returns from paddy (Tk/ha);

Q_y = Total quantity of (paddy) outputs (kg/ha);

P_y = Per unit prices of the paddy (Tk/kg);

Q_b = Total quantity of the concerned by-product (kg/ha);

P_b = Per unit prices of the relevant by-product (Tk/kg);

X_i = Quantity of the concerned ith inputs;

P_{xi} = Per unit price of the relevant ith inputs

TFC = Total fixed cost involved in production;

$i = 1,2,3,...,n$ (Number of inputs)

Gross return

Gross return was calculated by simply multiplying the total volume of output of rice with per unit price received by the farmers. It consisted of the sum of the volume of the main product and its by-product (Dillon and Hardaker, 1993).

Gross Return = Σ (Q x P)

Where Q = Output quantity; and P = Output price.

Gross margin

It is the difference between total return and variable cost.

Gross Margin = Gross return − Total variable cost

Net return

Net return was obtained by deducting all costs (variable and fixed) from gross return.

Net return, $\pi = \Sigma P_y Q_y - \Sigma (P_{xi} X_i) - TFC$.

Where, P_y = Per unit price-output; Q_y = Total quantity output; P_{xi} = Per unit price of i-th inputs; X_i = Quantity of the i-th inputs; TFC = Total fixed cost (Tk); and i = 1, 2, 3, ..., n (number of inputs).

Benefit-cost ratio (BCR)

The BCR is a relative measure used to compare benefit per cost unit. The BCR estimated gross returns and gross costs as a ratio. The formula (undiscounted) for measuring BCR is shown below:

Benefit-cost ratio = Gross benefit ÷ Gross cost

Weighted Average Index (WAI)

A weighted average (WA) is a type of average where each observation in the data set is multiplied by an assigned weight reflecting its importance prior to summing all data into a single average value.

$$WAI = \sum w_i x_i / \sum w_i$$

where, w_i indicates respective weights for the items.

For the four different categories under consideration in this study, the equation is as follows:

$$WAI = (LL * 0 + LI * 1 + SL * 2 + LL * 3)/N$$

Result and Discussion

Table 12 demonstrates the perception of farmers about climate change and extreme events over the last 20 years in both the study areas. About 91% and 96% of respondent farmers stated their perceptions+ on climate change in Netrokona and Sunamganj district, respectively. About 85% and 87% of the respondent farmers of Netrokona and Sunamganj district, respectively, reported about increased temperature over last 20 years in their respective areas. Again, according to the 76% and 80% of the farmers from Netrokona and Sunamganj, respectively, the intensity of day time heat has increased over the last two decades. Besides, respondent farmers of both the areas mentioned that events like unpredicted rainfall, changes of monsoon season, occurrences of drought, long summer season etc. has been increased in their respective areas over the last 20 years.

Table 13 represents the variety wise affected area and yield loss due to flood occurred in the study areas in 2020. It is apparent that varieties that have comparatively longer duration are more affected by the flood. Different hybrid varieties and BRRI dhan29 got severely affected in terms of area and yield in both the studied districts. It is to be noted that this year almost all of the cultivated varieties got rigorously affected by the early flood in the studied *haor* areas.

Table 12. Farmers' perception on climate change and extreme events over last 20 years in *Haors* ecosystems

	% farmers' response							
	Netrokona				Sunamganj			
	Increase	Decrease	No change	No response	Increase	Decrease	No change	No response
Perception of Climate change	91				96			
Temperature	85	4	9	2	87	3	8	2
Intensity of day time heat	76	12	10	2	80	7	8	5
Rainfall	17	75	8	-	11	70	15	4
Unpredicted rainfall	59	11	9	21	63	14	10	13
Changes of monsoon season	42	20	28	10	36	12	21	31
Lack of surface water	33	26	29	12	29	28	35	8
Occurrence of drought	61	11	21	7	58	11	17	15
Downstream of flood	45	4	41	10	38	6	41	15
Short winter season	35	15	26	24	41	19	13	27
Long summer season	41	8	32	19	44	13	19	24
High cold	47	12	21	20	38	31	17	14

Source: Field Survey, 2022

Table 13. Yield loss due to occurrence of flood in the study areas during Boro, 2021-22

	Transplanting date	**Harvesting**	**% Affected area**	**% Yield loss**
Netrokona				
BRRI dhan28	15-20 December	5-15 April	24.23	42.30
BRRI dhan29	10-15 December	8-20 April	26.92	89.13
Hybrid	10-28 December	7-22 April	27.85	92.10
Sunamganj				
BRRI dhan28	12-15 December	5-14 April	29.52	90.25
BRRI dhan29	6-12 December	10-22 April	32.26	95.56
Hybrid	5-20 December	10-25 April	31.22	96.85

Source: Field Survey, 2022

Table 14 demonstrates the years of flood occurrence along with the arrival date, specific stages of the crop that time, flooding depth, duration and recession date over the last 20 years in the studied areas of Netrokona and Sunamganj. In both the areas, severe flood occurred in 2017 and 2022 within the last 10 years. In almost every case, flood arrived at the end of the March to mid of April that were too much prolonged as the recession time were end of October to mid of November. It is to be noted that, this year only the areas of typical *haor* i.e., areas outside the embankments got affected by the early flash flood. Farmers also reported that most of the time the crops remain at panicle initiation to booting, flowering or milking stage during the arrival of flood.

Table 14. Yearly details about flood occurrence and crop stages during Boro season

Year	**Arrival date**	**Crop stage**	**Flooding depth (CM)**	**Duration (days)**	**Recession time (days)**
Netrokona					
2017	20-24 March	Panicle Initiation to Booting	76-200	20-220	25 October-10 November
2022	25-30 March	Booting to Flowering	40-240	-	Still inundated
Sunamganj					
2017	21-23 March	Panicle Initiation to Booting	200-300	210	01-05 November
2022	28-31 March	Flowering to Milking or Soft Dough	60-180	-	Still inundated

Source: Field Survey, 2022

Table 15 and 16 represent the input use pattern and production cost along with profitability of the respondent farmers, respectively, in the study areas during Boro 2021-22. Results indicate that farmers of Sunamganj used comparatively more hired labour than the farmers of Netrokona. This is because, a smaller number of family members are being involved in farming in Sunamganj and thus, this district is more dependent on migrant hired labour compared to the Netrokona. Again, the contract cost is also higher in case of Sunamganj as these works are mainly done by migrant workers from other district who charge more than the local labour whereas, Netrokona is abundant with local labour compared to Sunamganj.

Table 15. Input use pattern of farmers in Netrokona and Sunamganj during Boro, 2021-22

Input Items	Netrokona	Sunamganj	Price	
			Netrokona	Sunamganj
Human Labour (man-day/ha):	73	80	500	500
Hired	40	54	500	500
Family	33	26	500	500
Hired contract (transplanting, weeding and harvesting)	18950	23347	-	-
Seed (kg/ha)	29	35	105	76
Fertilizer (kg/ha):				
Urea	257	245	18	17
TSP	98	102	20	22
MoP	71	78	18	20
DAP	68	64	18	18
Gypsum	11	17	10	10
Sulpher	0	3	-	300
ZnSo4	2	2.5	180	180

Source: Field Survey, 2022

Despite of higher labour, fertilizer as well as variable cost, farmers of Sunamganj receive more gross return from paddy cultivation than those of Netrokona. Due to the remoteness of Khaliajuri and Mohanganj upazila of Netrokona, farmers of Sunamganj district were in a better position with extension service, access to input as well as selling their output. However, for both the study areas rice farming was a profitable enterprise considering both cash cost and full cost basis, due to the good price of paddy last year.

Table 16. Cost of production and profitability at farm level during Boro, 2021-22 in the study areas

Input-wise cost (BDT/ha)	Netrokona	Sunamganj
Seed	3045	2660
Seedling development	3245	3350
Land preparation (ploughing and laddering)	7774	7940
Human labour:	55450	63347
Hired	20000	27000
Family	16500	13000
Hired contract (transplanting, weeding and harvesting)	18950	23347
Fertilizer cost	9558	9741
Urea	4626	4165
TSP	1960	2244
MoP	1278	1560
DAP	1224	1152
Gypsum	110	170
Sulpher	-	-
ZnSo4	360	450
Irrigation	11540	11217
Pesticide:		
Herbicide	445	522
Insecticide and fungicide	3140	2921
Power thresher	3872	4120
Total variable cost	98069	105818
Interest on operating capital	550	610
Land rent	14950	15120
Total fixed cost	15500	15730
Total cost	113569	121548
Yield	6713	6895
Straw	6713	6895
Paddy price (Tk/kg)	25.62	26.25
Gross return	171987.06	180993.75
Gross margin	73918.06	75175.75
Net return	58418.06	59445.75
BCR (on cash cost)	**1.75**	**1.71**
BCR (on total cost)	**1.51**	**1.49**

Source: Field Survey, 2022

Farmers' Ranking of Adaptation Practices

Figure 3 shows the percentage of farmers adopting some common adaptation practices in the study areas. It is worth mentioning that taking loan is the most common adaptation practice in both the studied *haor* districts. About 52% and 43% respondent farmers of Netrokona and Sunamganj district, respectively, reported that they take loan to overcome from the crop loss or any natural disaster. It is to be noted that most of the cases farmers are taking loan from the informal sources i.e., *mohajon* with high interest rate in both the studied districts. Migration is another common adaptation practices which is getting more height in recent time in all the studied villages. Beside these, respondent farmers also mentioned about fishing, duck farming, homestead gardening as their common adaptation practices. It is to be noted that, nowadays scope of fishing is being limited for the marginal farmers in the study areas due to strict conditions imposed by the leasing authority or malpractice by the lease takers in the study areas.

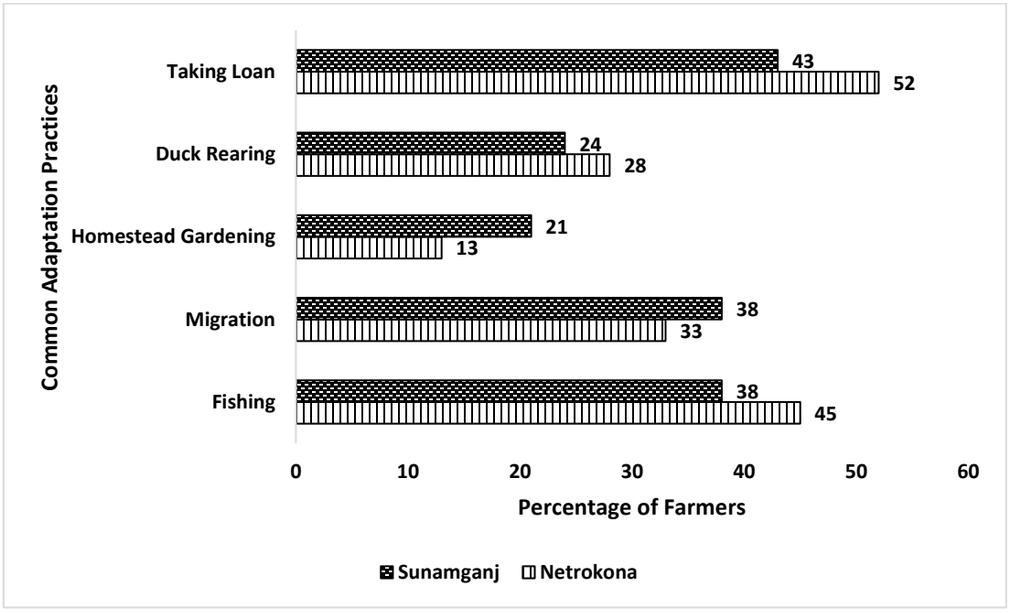

Figure 3: Common adaptation Practices implemented by farmers in Netrokona and Sunamganj

Table 17 represents farmers' ranking of some adaptation practices which are predominantly related to agricultural practices in the studied areas. Most of the farmers (72, 73, 66, 94, 82, 54 and 49) mentioned lack of money as the main factor for different adaptation practices in the study areas. From the weighted average index (WAI) it is apparent that, shifting of harvesting maturity is the top most adaptation practice of rice farmers in recent times. Respondent farmers reported that they harvest their paddy at 70-80% maturity whereas it was up to 80-90% maturity a decade before to avoid the loss of early flash flood especially in typical *haor* areas. Varietal diversification has been observed and also reported by the respondent farmers in the study areas. Adoption of different hybrid varieties is increasing day by day in *haor* areas which in results replacing the long duration varieties like BRRI dhan29 significantly. Besides these, early transplanting of seedling, short time migration, growing *rabi* crops and short duration varieties etc. are found as popular adaptation practices in the studied *haor* areas.

Table 17. Farmers' ranking of some adaptation practices and factors in the study areas

Name of Adaptation Practices	Lack of Land (LL)	Lack of Information (LI)	Shortage of Labor (SL)	Lack of Money (LM)	WAI	Rank
Shifting harvesting maturity	5	49	34	72	2.081	1
Varietal diversification	16	48	23	73	1.956	2
Early transplanting	11	55	28	66	1.931	3
Reduce number of livestock	55	5	6	94	1.869	4
Short time migration	60	10	8	82	1.700	5
Growing *rabi* crops	39	28	39	54	1.675	6
Short duration variety	11	82	18	49	1.657	7

Source: Field Survey, 2022 and Authors' calculation

Table 18 shows the percentage of total paddy being marketed through different paddy marketing channels in the study areas. Farmer-Bepari-Aratdar-Miller and Farmer-Bepari-Miller appeared as the most frequently used marketing channels in both the study areas. From Table 18, it is evident that about 26% and 31% of paddy of Netrokona and Sunamganj, respectively, being traded through Farmer-Bepari-Aratdar-Miller channel. Again, 38% and 30% of paddy of Netrokona and Sunamganj, respectively, being marketed through Farmer-Bepari-Miller channel. It is to be noted that, due to the poor transportation facilities and remoteness the paddy marketing channels are comparatively shorter in those studied areas. Inadequate facilities of storage, poor transportation system force the farmers to sell their paddy just after harvesting. Rest of the paddy are being sold to the nearest local markets where vans and boats are the most frequently used vehicle for transporting paddy. Farmers mentioned about poor transportation facilities, inadequate drying and storing facilities, lack of information, lack of rice mills and fewer number of buyers and processors, low price of paddy during harvesting as the main constraints in paddy marketing.

Table 18. Paddy marketing channel in the study areas

Paddy marketing channel	% of Paddy	
	Netrokona	**Sunamganj**
Farmer-Bepari-Aratdar-Miller	26	31
Farmer-Bepari-Miller	38	30
Farmer-Aratdar-Miller	4	7
Farmer-Millers' Agent	0	9
Farmer-Faria-Aratdar-Miller	6	7
Farmer-Faria-Bepari-Miller	9	5
Farmer-Miller	0	4
Farmers-Bepari- Miller (Ashuganj)	16	7

Source: Field Survey, 2022

Conclusion

Haor represents a unique ecosystem which plays a vital role in achieving rice self-sufficiency in the country. Though the farmers are well aware about the climatic hazards they are facing since very beginning but most often they are not able to figure out the exit plan to avoid or recover the losses. Rice farming is a profitable endeavor in the *haor* areas if the farmers can escape from early flash flood. Even though they are trying to make some adaptation practices but utmost success is yet to come due to lack of effective technologies and inclusive extension and marketing services. As the scope of fishing is being limited for the farmers due to the leasing arrangements and conditions in the study areas, it is therefore an urgent call to create some earning opportunities for the farmers in the *haor* areas. Furthermore, holistic approach needs to be taken to improve the livelihood of the *haor* farmers which will ultimately help to attain country's food security.

STUDY 4: ADOPTION DETERMINANTS AND PROFITABILITY OF STRESS TOLERANT RICE IN SELECTED AREAS OF BANGLADESH

MS Rahaman, MC Rahman, MA Islam, MAR Sarkar and MS Islam

Introduction

When it comes to the effects of climate change, Bangladesh is among the world's most at-risk nations. Although it was ranked as the most climate-vulnerable nation in 2010 by the Global Climate Risk Index (GCRI) (Kreft et al. 2017), Bangladesh ranked sixth in that category in 2017 (Harmeling 2009). According to the Global Climate Risk Index (GCRI) 2010, which looks at the years 1990-2008, natural disasters in Bangladesh claimed the lives of an average of 8241 people each year, caused an average of US $ 1.2 billion in annual damages, and resulted in a yearly GDP loss of 1.81 percent (Harmeling 2009). Bangladesh's agriculture is particularly vulnerable to climate-induced calamities, which limit the country's ability to produce enough food to feed its population and threaten food security.

Bangladesh's agro-ecological zones (AEZ) suffer from climate-induced disasters that affect agricultural production. The hydro-climatic factors affecting the agricultural sector in the country include rising temperatures, erratic and unpredictable rainfall, winter shortening, foggy conditions, rising sea level, increasing floods, and increased intensity of cyclones and storm surges (Mondal et al., 2012). Rahman et al., (2017) reported that unfavorable conditions could be exacerbated in developing countries like Bangladesh. In Bangladesh, coastal areas constitute about 2.5 million hectares which amounts to about 25 percent of the total cropland of the country. Of this, nearly 0.84 million hectares are affected by varying salinity intensities (Karim et al 1990). Salinity intrusion on the interior coast found that the increasing concentration of salinity will create more pressure on the farmer by reducing yield and threatening livelihood, income generation and food security (Lubna and Baten, 2012). According to Sikder (2012), Bangladesh is one of the worst-affected countries facing the early impacts of climate change, particularly in the agricultural sector. Haque (2006) studied the salinity problems and crop production in coastal reason of Bangladesh, which showed that about 53% of the coastal areas are affected by salinity. In addition, Singh (2003) shows that contract farming as a system affected growers positively or negatively depending on the economy's context. Therefore, the cultivation of rice has become highly vulnerable in Bangladesh.

Few studies have examined the profitability of rice cultivation in Bangladesh's coastal regions.This study had been taken to assess the current level of adoption of climate resilient rice varieties, as well as to the profitability and adoption determinants of rice production in coastal regions in Boro season. This study hopes to facilitate a successful rice revolution and is expected to provide valuable data helpful in formulating an appropriate policy for the widespread cultivation of rice in coastal areas of Bangladesh.

Specific objectives

1. to determine the adoption status of climate-resilient rice varieties in the Boro season;
2. to compare profitability between climate-resilient rice varieties and other rice cultivars; and
3. to identify the factors affecting the adoption decision of climate-resilient rice varieties

Methodology

Study area and Data

For this study, the required data were obtained from the farmers of the two Upazila, Asasuni and Shyamnagar of Satkhira district. The data were obtained from both primary and secondary sources. From each Upazila, 50 sample farmers were taken; thus, a total of 100 were selected randomly to collect socio-demographic and farm-level data to identify factors affecting the adoption decision of the climate-resilient rice cultivars. Besides, an expert panel interview consisting of Sub-assistant Agricultural Officer (SAAO) and Upazila Agriculture Officer (UAO) was conducted in both Upazila

to validate the data collected from the farmers. The selected farmers were interviewed using a pretested structured questionnaire.

In this study, the dry season (November and May) was selected because salinity severely affected crop production in the Satkhira district during the dry season. We have divided the rice cultivars found in this survey into two groups, namely salinity tolerant cultivars and other cultivars. Salinity-tolerant varieties include BRRI dhan 67, BINA dhan-8 and BINA dhan-10; and other cultivars include BRRI dhan28, BRRI dhan88, SL-8H, Tejgold, ACI, Shakti etc.

The data were processed using both descriptive and inferential statistics. The Logit model was used to identify the factors behind the adoption decision of salinity-tolerant rice varieties.

Analytical Techniques and Model

Descriptive Statistics

Descriptive Statistics was used to get the simple measures like average, percentage and ratio. It included socio-economic profiles of paddy farmers, production practices and input use, costs and returns of paddy farming.

Analytical tools

Activity Budgets

To determine per hectare profitability for each of the selected paddy farming from the view point of individual farmers, the following algebraic equation was followed:

$$\Pi = \sum Q_y . P_y + \sum Q_b . P_b + \sum_{i=1}^{n} (X_i P_{xi}) - TFC$$

Where,

$\prod$= Net returns from paddy (Tk/ha);

Q_y = Total quantity of (paddy) outputs (kg/ha);

P_y = Per unit prices of the paddy (Tk/kg);

Q_b = Total quantity of the concerned by-product (kg/ha);

P_b = Per unit prices of the relevant by-product (Tk/kg);

X_i = Quantity of the concerned i^{th} inputs;

P_{xi} = Per unit price of the relevant i^{th} inputs

TFC = Total fixed cost involved in production;

$i = 1,2,3,...,n$ (Number of inputs)

Gross return

Gross return was calculated by simply multiplying the total volume of output of rice with per unit price received by the farmers. It consisted of the sum of the volume of the main product and its by-product (Dillon and Hardaker, 1993).

Gross Return = Σ (Q x P)

Where Q = Output quantity; and P = Output price.

Gross margin

It is the difference between total return and variable cost.

Gross Margin = Gross return − Total variable cost

Net return

Net return was obtained by deducting all costs (variable and fixed) from gross return.

Net return, $\pi = \Sigma P_y Q_y - \Sigma (P_{xi} X_i) - TFC$.
Where, P_y = Per unit price-output; Q_y = Total quantity output; P_{xi} = Per unit price of i-th inputs; X_i = Quantity of the i-th inputs; TFC = Total fixed cost (Tk); and i = 1, 2, 3, ..., n (number of inputs).

Benefit-cost ratio (BCR)

The BCR is a relative measure used to compare benefit per cost unit. The BCR estimated gross returns and gross costs as a ratio. The formula (undiscounted) for measuring BCR is shown below:
Benefit-cost ratio = Gross benefit ÷ Gross cost

Econometric Model: Logistic Model

Previous empirical and theoretical research indicated that the logistic curve or the S-shaped diffusion path characterizes fairly well the adoption pattern of new agricultural technologies [Griliches (1957), Feder and O'Mara (1982), Jarvis (1982) and Rogers (1983)]. According to the hypothesis, diffusion is slow when new technology is introduced. Through the process of "demonstration effects" generated by the early adopters (the most progressive), diffusion increases rapidly as information and experience spreads to other producers. Eventually, a long-run equilibrium is reached after all potential adopters have been exposed to and adopted the new technology. The logistic function traces out this path and defines the rate of adoption and the long-run equilibrium.

Logistic regression analysis is a unit/multivariate technique that allows for estimating the probability that an event occurs or not by predicting a binary dependent outcome from a set of independent variables. Logit model was used to estimate the effects of various quantitative and qualitative factors on the adoption decision of salinity tolerant rice variety in Satkhira District. When the dependent variable is binary, the linear probability model (LPM), Logit and Probit model can be used (Ramnathan 1998; Green 2000). Logit and Probit models are quite comparable; however, the logistic has slightly flatter tails. Thus, the choice between the two is one of convenience and ready availability of computer programs. On this score, the Logit model is usually used in preference to the probit (Gujirati 1995). However, Logit model have been widely used in order to explore the factors affecting farmers' decision in adoption studies (Jarvis, 1981; Feder and O'Mara 1992; Rogers, 1983; Adsena et al., 2000; and Vanderveer, 2001).

Farmer's adoption of climate-resilient rice varieties is the dependent variable of this study which takes one (1) if the farmers adopted and zero (0) otherwise. A binary logit model was employed for this study. Mathematically, the model can be specified following (Cameron & Trivedi, 2005; Gujarati & Porter, 1999; Wooldridge, 2010):

$$P_i = \frac{e^{Z_i}}{1 + e^{Z_i}}$$

where P_i represents the probability that the i^{th} farmers adopted salinity tolerant rice varieties in Boro season and Z_i is a linear function of independent variables (X) and is expressed as:

$$Z_i = \beta_0 + \beta_i \sum_{i=1}^{n} X_i + U_i$$

where β_0 is the constant term, β_i is coefficients of independent variables, X_i independent variables, and U_i is the error term. The β_i tells us how the log-odds in favor of adoption of climate resilient rice varieties change as the independent variables change. The odds to be used can be defined as the ratio of the probability that farmers adopt climate resilient rice varieties for cultivation (P_i) to the probability that he/she is not (1—P_i), i.e.

$$\frac{P}{1-P} = e^{Z_i}$$

$$\ln\left(\frac{P}{1-P}\right) = \ln(e^{Z_i}) \Rightarrow \ln\left(\frac{P}{1-P}\right) = Z_i$$

Finally, the model is specified as follows:

$$\ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_i \sum_{i=1}^{n} X_i + U_i$$

There is no direct way to explain the effect of a unit increase in an explanatory variable on the probability of adoption of climate resilient rice varieties keeping other variables constant. We can obtain an approximate answer by taking derivatives with respect to X_i, which of course makes sense for nonlinear econometric models (Asrat, Belay, & Hamito, 2004). This result tells us by how much the dependent variable changes with respect to a small change in the independent variables. As a result, the effect of each significant independent variable on the probability of adopting climate-resilient rice varieties in Boro season is computed by keeping other variables constant, i.e.

$$\frac{dP}{dX_i} = \frac{d}{dX_i}\left(\frac{e^{Z_i}}{1+e^{Z_i}}\right) = P_i(1-P_i)\beta_i$$

Both literature review and focus group discussion were undertaken to identify potential independent variables influencing the adoption decision of climate-resilient rice varieties in the Boro season. The effect of independent variables on the dependent variable was hypothesized based on the information obtained from a theoretical literature review of previous works (Birhanu, 2015; Cheffo et al., 2015; George, Olaoye, Akande, & Oghobase, 2010; Ofuoku, Olele, & Emah, 2008) and focus group discussions. The potential variables are listed in the table below (Table 19).

Table 19. Definition of working variables of logit model

Variables	**Definitions**	**Expected sign**
Dependent variable		
Adoption of salinity tolerant rice varieties	1=Adopters, 0=Otherwise	
Independent variable		
Age	Years	+
Rice cultivation experience	Years engaged in rice cultivation	+
Schooling	Years of schooling	+
Occupation	1= Only farming	+
Family size	Number	+
Family members involve in farming	Number	+
Farm size	Hectare	+
Price difference	The average price difference between salinity tolerant cultivars and other rice cultivars (tk/kg)	+/-
Market demand	1= Yes	+
Eating quality	Farmer perceives Eating quality of aromatic rice is good than other rice varieties (1 = agree, 0 = disagree)	+
Yield difference	Kg/ha	+/-
Distance to UAO	Kilometer	-
Distance to local market	Kilometer	-
Training	1= received training	+
Extension service	1= received extension service	+
Participate in field demonstration	1= yes, 0=otherwise	+
Membership of any agricultural organization	1= yes, 0=otherwise	+
Credit	1= received	+

Variables	Definitions	Expected sign
Severity of salinity	1 if the respondent faces low severity, 2 for moderate severity, 3 for high severity, and 0 for no severity. The data was then normalized as the perception of salinity severity may vary among respondents. The normalized value of severity was used in the model.	+
Disease infestation	Farmer perceives disease infestation in aromatic varieties (1= higher than other varieties)	-
Total varieties cultivated	Number	+

Results and Discussion

Adoption status

Table 20 represent the adoption status of climate-resilient rice varieties (salinity tolerant) in the Satkhira district and Bangladesh. Results revealed that in the Boro season, the farmers of Satkhira district cultivated BRRI dhan67, BINA dhan-8 and BINA dhan-10 rice cultivars. Where BRRI dhan67 is the highest (6.31%) adopted, followed by BINA dhan-10 (2.05%), and BINA dhan-8 (0.89%). Among the adopted rice varieties, BINA dhan-8 yielded the highest (4.03t/ha), followed by BRRI dhan67 (3.93t/ha) and BINA dhan-10 (3.90t/ha). Furthermore, 1.67% area of the Boro season was covered by the salinity-tolerant rice varieties in Bangladesh in 2021-22.

Table 20. Adoption status of saline-tolerant rice varieties in 2021-22

Varieties	Bangladesh		Satkhira	
	Area (%)	Rice Yield (t/ha)	Area (%)	Rice Yield (t/ha)
Saline tolerant varieties	**1.67**	**4.32**	**9.25**	**3.95**
BRRI dhan47	0.41	3.79	0	0
BRRI dhan67	0.75	3.89	6.31	3.93
BINA dhan-8	0.12	3.76	0.89	4.03
BINA dhan-10	0.38	3.9	2.05	3.9
Other varieties	**98.33**	**3.87**	**90.75**	**4.18**

Source: Field survey 2021-22 and DAE

Profitability

Input use pattern

Table 21 represents hectare-wise input used in the study region for Boro seasons. In the study area, farmers regularly hired labor on a contractual basis for the three major labor-intensive intercultural operations such as transplanting, harvesting, and carrying. In contrast, land preparation, weeding, fertilizer and insecticides application, and post-harvest processing were done by hiring labor on a daily wage basis. Besides, most farmers in the Boro season rely on the combined harvester and power thresher for harvesting and threshing rice on a custom custom-hired basis.

Results revealed that paddy cultivation requires almost the same amount of labor for both types of varieties. The salinity-tolerant rice varieties used 122 (man-days/ha) of labor; on the other hand, other varieties require 123 (man-days/ha). The seed rates for salinity tolerant and other varieties were 37 and 40 kg/ha, respectively, indicating farmers used a substantially higher amount of seed than the BRRI recommended rate (25 to 30 kg/ha). Furthermore, other cultivars require comparatively higher amounts of urea than the salinity varieties. However, the application of other fertilizers in paddy cultivation was found almost similar in both cases, except for gypsum use.

Table 21. Per hectare input used for rice cultivation in Boro seasons in Satkhira districts, 2021-22

Input Items	Varieties	
	Salinity tolerant varieties	Other varieties
Human Labour (man-day/ha):	122	123
Family	23	25
Hired	39	36
Hired contract (transplanting, weeding and harvesting)	60	62
Seed (kg/ha)	37	40
Fertilizer (kg/ha):		
Urea	202	235
TSP	74	74
MoP	60	70
DAP	75	74
Gypsum	37	74
ZnSo4	7	7
Mg	5	5
Theovit	5.5	6

Source: Field survey 2021-22

Production cost

Per hectare, human labor costs were Tk. 67,100 and Tk. 68,880 for salinity tolerant varieties and other varieties cultivation in the study area, which is 43.93 and 44.06 percent of the total cost, respectively. The fertilizer cost of cultivating other varieties (Tk.14,883/ha) was higher than the salinity tolerant varieties (Tk 13,115/ha). Irrigation cost was almost the same for both types of varieties. Per hectare total variable cost of other varieties, cultivation was higher than that of salinity tolerant rice cultivars (Table 22).

Table 22. Per hectare cost (Tk/ha) of rice cultivation in Boro season in the study area, 2021-22.

Input-wise cost	Varieties			
	Salinity tolerant varieties		Other varieties	
	Taka/ha	% of total cost	Taka/ha	% of total cost
Seed	2405	1.57	2400	1.54
Seedling development	2993	1.96	3000	1.92
Human labour:	67100	43.93	68880	44.06
Family	12650	8.28	14000	8.95
Hired	21450	14.04	20160	12.89
Hired contract (transplanting, weeding, and harvesting)	33000	21.61	34720	22.21
Land preparation (ploughing and laddering)	8217	5.38	8300	5.31
Fertilizer cost	13115	8.59	14883	9.52
Urea	3636	2.38	4113	2.63
TSP	1850	1.21	1362	0.87
MoP	1020	0.67	1512	0.97
DAP	1350	0.88	1369	0.88
Gypsum	444	0.29	1221	0.78
ZnSo4	1120	0.73	1281	0.82
Mg	500	0.33	675	0.43
Theovit	1045	0.68	1200	0.77
Mannure	2150	1.41	2150	1.38
Irrigation	14850	9.72	14940	9.56
Pesticide:	7020	4.60	5665	3.62
Herbicide	610	0.40	592	0.38
Insecticide and fungicide	6410	4.20	5073	3.24

Input-wise cost	Varieties			
	Salinity tolerant varieties		Other varieties	
	Taka/ha	% of total cost	Taka/ha	% of total cost
Power thresher	3500	2.29	3875	2.48
Total variable cost	106550	69.76	107943	69.04
Interest on operating capital	1997	1.31	2032	1.30
Land rent	31538	20.65	32367	20.70
Total fixed cost	46185	30.24	48399	30.96
Total cost	152735	100.00	156342	100.00

Source: Field survey 2021-22

Profitability

The per-hectare average yield of other cultivars (6,227 kg) was higher, followed by salinity-tolerant rice cultivars (5,985 kg). Due to the favorable climate, low paste and disease infestation, and considerable irrigation facilities, Boro season rice yield was higher than last year. Similarly, per hectare, the average gross margin of other rice cultivars (Tk. 76,743) was higher, followed by salinity-tolerant cultivars (Tk. 64,029). It's because other cultivars (including varieties like BRRI dhan28 and BRRI dhan88) gets higher price than salinity-tolerant cultivars. BCR (based on full cost) was the highest, 1.18 for other cultivars as well, followed by 1.12 for salinity-tolerant rice cultivars (Table 23).

Table 23. Per hectare profitability of rice cultivation in Boro season, 2021-22.

Items	Salinity tolerant varieties	Other varieties
Total costs (TK./ha)	152735	156342
Total variable costs (TK./ha)	106550	107943
Total fixed cost (TK./ha)	46185	48399
Yield (kg/ha)	5985	6227
Paddy price (Tk/Kg)	26	27.25
Return from paddy (TK./ha)	155610	169686
Return from straw (TK./ha)	14969	15000
Gross return (TK./ha)	170579	184686
Gross margin (TK./ha)	64029	76743
Net return (TK./ha)	17844	28344
Unit cost of production (TK./kg)	25.52	25.11
BCR (full cost basis)	1.12	1.18

Source: Field survey 2021-22

Outcome of the model

The chi-square value is statistically significant at less than 1% significance level and the Pseudo R^2 value was 0.751. This indicates that the overall significance of the model is good. The marginal effects of variations in explanatory variables on the likelihood of adoption were calculated to classify the determinants of climate-resilient rice cultivars adoption (see Table 24). The model result revealed that among the 21 independent variables, only 12 variables were statistically significant. Only four variables were significant at less than 1% significance level among twelve significant variables. These variables are the rice cultivation year, training, any agricultural organization's membership and soil salinity's severity (Table 24).

The adoption decision of climate-resilient rice cultivars was influenced by socioeconomic, market and institutional factors. The factors rice cultivation experience, schooling year, farm size, market demand, eating quality, training, extension service, participation in the field demonstration program, membership of any agricultural organization, and the severity of salinity had a positive and statistically significant effect on the adoption of climate resilient rice cultivars. The probability of adopting climate-resilient rice cultivars will increase by 13.5%, 9.10%, 6.10%, 3.5%, 6.5%, 15.1%, 5.4%, 12.9%, 7.8%, and 17.9% if the farmer's rice cultivation experience, schooling year, ln farm size, market demand,

eating quality, training, extension service, participation in the field demonstration program, membership of any agricultural organization, and the severity of salinity is increased by 1 percent.

On the other hand, price difference and yield difference were found to be statistically significant and negative. This implies that if the price difference and yield difference increase by 1 percent (compared to other cultivars), the adoption of climate-resilient rice cultivars will decrease by 4.30% and 6.20% in the study area.

However, the factors age, occupation, family size, family members' involvement in agriculture, credit, diseases infestation, and total varieties cultivated had positive coefficients but were not significant, which implies these variables do not affect the adoption decision of climate resilient cultivars in the study area.

Table 24. Estimates of logit regression for the adoption decision of salinity-tolerant rice varieties

Variables	Coefficient	Standard Error	Marginal Effect
Age	0.003	0.035	0.001
Rice cultivation experience	2.046***	0.821	0.135***
Schooling	1.036**	0.516	0.091**
Occupation	0.002	0.004	0.002
Family size	0.148	0.143	0.053
Family members involve in farming	0.147	0.182	0.031
Farm size	0.825**	0.381	0.061**
Price difference	-0.977*	-0.491	- 0.043*
Market demand	0.304*	0.159	0.035*
Eating quality	0.093**	0.041	0.069**
Yield difference	-0.512	0.272	0.062
Distance to UAO	-0.235	-0.652	0.005
Distance to local market	-0.551	-0.492	0.043
Training	3.630***	1.355	0.151***
Extension service	0.603*	0.291	0.054*
Participate in field demonstration	2.652**	1.229	0.129**
Membership of any agricultural organization	3.553***	1.202	0.078***
Credit	0.201	0.232	0.013
Severity of salinity	3.634***	1.271	0.179***
Disease infestation	0.912	1.008	0.065
Total varieties cultivated	0.367	0.231	0.003
Constant	-1.054**	-0.443	
Log-likelihood	–136.94		
Number of observations	100		
Wald Chi^2	66.900		
Prob> chi^2	0.000		
Pseudo R^2	0.751		

Note: *, ** and *** mean significant at 10%, 5% and 1% probability level, respectively.
Source: Field survey 2021-22

Conclusion

In Bangladesh, coastal salinization is a persistent issue, and policymakers are striving to make adaptation strategies to address it. This study examined the adoption status of climate-resilient cultivars, profitability and factors influencing the adoption decision of climate-resilient rice cultivars in the salinity-affected area. The finding of this study revealed that in Satkhira district, almost 9.25% area of the dry season was devoted to salinity-tolerant rice cultivars, and the rest of the area were devoted to other varieties. Whereas, it was 1.6 percent of Bangladesh's total dry area rice cultivation. Results also revealed that the yield of salinity-tolerant cultivars was lower than the other cultivars. The profitability analysis depicts that planting other cultivars was comparatively more profitable than the

salinity-tolerant rice cultivars. The BCR of salinity-tolerant rice cultivars was 1.12, and 1.18 for other cultivars.

Additionally, the econometric model results indicated that the rice cultivation experience, schooling year, farm size, market demand, eating quality, training, extension service, participation in the field demonstration program, membership of any agricultural organization, and the severity of salinity had statistically significant effect on adoption of climate resilient rice cultivars. The findings suggest that in order to expand the cultivation of climate-resilient cultivars in the study region, particular attention should be paid to the existing variability in socio-economic and institutional aspects. However, the adoption of salinity-tolerant rice cultivars was constrained by price and yield disparities. To enhance the adoption rate, special care must be taken to raise the price and yield of salinity-tolerant rice cultivars.

So, to rapidly increase the adoption rate of salinity-tolerant rice cultivars in saline-affected areas of Bangladesh, government, non-government and research organizations should come forward to provide agriculture extension services, training, demonstration of new technologies and setting fair paddy prices. The research institutes and universities should also strengthen their research to develop improved technologies like salinity tolerant higher yield potential varieties. The government should also evaluate and acknowledge local and indigenous agricultural adaptation strategies in order to boost the adoption of salinity-tolerant cultivars and produce more paddy in salinity-affected regions.

PROGRAM AREA-II: PRODUCTION ECONOMICS

STUDY 1: ESTIMATION OF COSTS AND RETURN OF MV RICE CULTIVATION AT THE FARM LEVEL

MS Islam, MA Islam, MC Rahman, A Chowdhury, MS Rahaman, L Deb, SMMH Noman and SA Jui

Introduction

Economic decisions are primarily concerned with the most profitable level of input used in the production process. The viability of technology mostly depends on its cost and return. Therefore, it is indispensable to know the cost and return of rice cultivation, where farmers use different technologies. Moreover, through the cost and return analysis, researchers and planners can get an indication in developing a technology that will help the farmers increase return and reduce cost. Thus, the present study has been undertaken to assess the profitability of rice cultivation in Bangladesh with the following specific objectives;

- to determine the level of inputs used in MV Aus, MV T. Aman, and MV Boro rice cultivation;
- to estimate the cost of MV rice cultivation in different seasons; and
- to evaluate the profitability of MV Aus, MV T. Aman, and MV Boro rice cultivation at the farm level.

Methodology

Multistage random sampling technique was adopted to select farmers from all the 14 agricultural regions of Bangladesh. Farm-level data on input use patterns, prices of inputs and outputs, and yields were collected from 210, 280, and 280 farmers for the Aus, T. Aman, and Boro seasons, respectively. Thus, the number of total respondents was 770. Data were collected through face-to-face using a structured questionnaire. The descriptive statistical technique was applied to analyze the data, and tabular method was used to present the results.

Results and Discussion

Inputs use pattern

Farmers mainly hired contractual laborers for the three major labor-intensive intercultural operations such as transplanting, harvesting, and carrying. They also hired labor on a daily wage basis for other intercultural operations such as land preparation, weeding, and post-harvest processing. Besides, most farmers rely on power threshers for threshing rice on a custom hired basis. The highest number of human labor (116 man-days/ha) was used for MV Boro cultivation, followed by MV Aman (106 man-days/ha) and MV T. Aus (100 man-days/ha) (Table 25).

The seed rates for MV Aus, MV T. Aman, and MV Boro rice were 31, 33, and 36 kg/ha, respectively, indicating that the farmers substantially used a higher amount of seed than BRRI recommended rate (25 to 30 kg/ha). On an average, in T. Aman season, the farmer’s rate of urea application was a bit lower than the BRRI recommendation. In Boro season, farmers applied urea below the BRRI recommended dose, whereas T. Aus farmers overused it. In addition to that, the application of phosphate fertilizer, including TSP, was considerably higher than the BRRI recommendation in the T. Aus season but lower in Boro and Aman seasons. At the same time, farmers' rate of MoP usage was lower than BRRI recommendations in the Boro season. On the other hand, gypsum was applied less than the BRRI recommendation in all the seasons.

Table 25. Per hectare Input used for MV rice cultivation in different seasons in Bangladesh, 2021-22.

Input Items	Season		
	Aus	**Aman**	**Boro**
Human Labour (man-day/ha):	100	106	116
Hired	34	37	39
Family	15	14	16
Hired contract (transplanting, weeding and harvesting)	51	55	61
Seed (kg/ha)	31	33	36
Fertilizer (kg/ha):			
Urea	140(125)	151(150)	196(250)
TSP	65(44)	52(56)	79(94)
MoP	74(67)	89(75)	100(123)
DAP	62(44)	89(56)	136(94)
Gypsum	13(33)	35(50)	52(62)
ZnSo4	3(7)	4(7)	7(10)
Mg	1	3	4
Theovit	2	4	5

Note: Parentheses indicate average BRRI recommended fertilizer doses (Adhunik Dhaner Chas book, 2020).
Source: Field Survey, 2021-22

Rice production costs

Per hectare human labor costs were Tk.47,730 Tk. 51,422 and Tk. 64,145 for MV Aus, MV T. Aman, and MV Boro rice cultivation. Fertilizer cost of Boro (Tk. 15,963/ha) and T. Aman rice (Tk 8,863 /ha) were higher than that of Aus (Tk 7,132/ha) rice cultivation. A considerable portion of respondents reported that there was the violation of government declared retail price of fertilizers in the local markets. Irrigation cost was higher (Tk. 23,434/ha) for MV Boro rice cultivation than that of MV Aman (Tk. 1,561/ha). Irrigation cost of Boro season in 2021-22 was a bit higher than the previous year because of a considerable increase in fuel price. Per hectare total variable cost of Boro rice cultivation was higher as well, than those for T. Aman and Aus rice cultivation. (Table 26).

Table 26. Per hectare cost (Tk/ha) of MV rice cultivation in different seasons in Bangladesh, 2021-22.

Input-wise cost	Season		
	Aus	**Aman**	**Boro**
Seed	1808	1997	2432
Seedling development	2470	3032	2712
Land preparation (ploughing and laddering)	6602	6356	7675
Human labour:	47730	51422	64145
Hired	15300	16560	19525
Family	6750	6440	8660
Hired contract (transplanting, weeding, and harvesting)	25680	28422	35960
Fertilizer cost	7132	8863	15963
Irrigation	0	1561	23434
Pesticide:	4627	5234	5365
Herbicide	512	1023	1034
Insecticide and fungicide	4115	4211	4331
Power thresher	3955	3967	4058
Total variable cost	**74324**	**82432**	**125784**
Interest on operating capital	1115	1236	1887
Land rent	22861	24583	25844
Total fixed cost	**30726**	**32259**	**36391**
Total cost	**105050**	**114691**	**162175**

Source: Field Survey, 2021-22

Profitability

The per hectare yield in Boro season (6,539 kg) was higher, followed by T. Aman (4,622 kg) and Aus season (4,223 kg). Selling price of paddy was the highest in Aman season and lowest in Aus. Comparative profitability scenario shows that, per hectare gross margin of rice cultivation in the Aman season (Tk. 64,650) was higher, followed by Boro (Tk. 54,573) and Aus season (Tk. 34,064) (Table 27). Similarly, BCR (based on full cost) was the highest (1.28) in the Aman season, followed by 1.11 and 1.03 in Boro and Aus seasons, respectively (Table 27). Profitability ratios are a class of financial metrics used to assess an enterprise's ability to generate earnings compared to its expenses and other relevant costs incurred during a specific period (James, 2009). Here gross profit ratio is 30, 31 and 44 for Boro, Aus and T. Aman, respectively. A high-profit ratio is an indication that the farmers are selling their produce at a high-profit level.

Table 27. Per hectare profitability of MV rice cultivation in different seasons in Bangladesh, 2020-21.

Items		**Aus**	**Aman**	**Boro**
1	Total costs (TK./ha) (2+3)	105050	114691	162175
2	Total variable costs (TK./ha)	74324	82432	125784
3	Total fixed cost (TK./ha)	30726	32259	36391
4	Yield (kg/ha)	**4223**	**4622**	**6539**
5	Market value of paddy (TK./ha) (4*11)	97129	129416	170014
6	Market value of straw (TK./ha)	11259	17666	10343
7	Gross benefit (GB) (TK./ha) (5+6)	108388	147082	180357
8	Gross margin (GM) (TK./ha) (7-2)	34064	64650	54573
9	Gross profit ratio ((GM*100)/GB)	31	44	30
10	Net return (TK./ha) (7-1)	3338.14	32390.52	18182.24
11	Cost of production (TK./kg)	24.88	24.81	24.80
12	Selling price of grain (TK./kg)	23	28	26
13	BCR (full cost basis) (7/1)	**1.03**	**1.28**	**1.11**

Source: Field Survey, 2021-22

Conclusion

Farmers mainly used hired labor on contractual basis for the three major labor-intensive intercultural operations of transplanting, harvesting, and carrying. The highest number of human labor (116 man-days/ha) was used for MV Boro cultivation. Farmers used more seed than the BRRI recommended rate (25 to 30 kg/ha). On an average, in T. Aman season, the farmer’s urea application rate was a bit lower than the BRRI recommendation. In Boro season, farmers applied urea below the BRRI recommended dose, whereas Aus farmers overused it. Fertilizer cost of Boro (Tk. 15,963/ha) and T. Aman rice (Tk 8,863 /ha) were higher than that of Aus (Tk 7,132/ha) rice cultivation. Irrigation cost of Boro season in 2021-22 was a bit higher than that of the last year because of a considerable increase in fuel price. Per hectare yield of Boro season (6,539 kg) was higher, followed by T. Aman (4,622 kg) and Aus season (4,223 kg). Per hectare gross margin of rice cultivation in the T. Aman season (Tk. 64,650) was higher, followed by Boro (Tk. 54,573) and Aus season (Tk. 34,064). Similarly, per hectare net returns for T. Aman (Tk. 32,391) was higher, followed by Boro (Tk. 18,182) and Aus (Tk. 3,338). Overall, rice cultivation was profitable in the current year due to the higher yield and market price. The gross profit ratio is 30, 31 and 44 for Boro, Aus and T. Aman, respectively. A high-profit ratio is an indication that the farmers are selling their produce at a high-profit level.

STUDY 2: AN ECONOMIC INVESTIGATION OF RICE SEED PRODUCTION STATUS IN A SELECTED AREA OF BANGLADESH

SMMH Noman, L Deb, A Chowdhury, SA Jui, and MS Islam

Introduction

Contract growers (CG) play a key role in supplying seed to the farmers through BADC and non-contract growers (non-CG) supplies their seed to local farmers, dealers, and private seed companies etc. Good quality seed alone can increase the yield by 15-20%. Rice seed production is dominated by Bangladesh Agricultural Development Corporation (BADC) through the production of Truthfully Labelled Seed (TLS) in its contract growing zones. The study was conducted in Jashore district taking sixty seed growers evenly from the contract and non-contract growers of both Aman and Boro seasons. Understanding the seed production system requires studying the seed growers incorporating all the costs incurred in the process of making seed and identifying the different agronomical practices needed which is of utmost importance to see the difference between rice production and seed production. The study aimed to find out the economics of TLS production of rice of both contract and non-contract growers and to document the constraints of TLS production of rice.

Methodology

Jashore Sadar and Chowgacha Upazila of Jashore district were purposively selected for the study as it is one of the largest contract seed growing zones of Bangladesh Agricultural Development Corporation (BADC). Sixty seed producing farmers were purposively selected and interviewed of which 30 were contract growers and the rest 30 were independent seed producing farmers. Boro and T. Aman seasons were taken into account as those two are the prime rice growing seasons in the country.

Analytical tools

Cost and return analysis

The following profit equation was employed to assess the profitability of aromatic rice production.
Net margin/return of producer;

$$\Pi = TR - TC$$

Where,

$\prod$= Net return (Tk./ha)

TR= Total return (Tk./ha)

TC= Total costs (Tk./ha)

$$\prod = \sum Q_y \,.\, P_y \; + \sum Q_b \,.\, P_b \; - \sum_{i=1}^{n} (X_i . P_{xi}) - TFC$$

Where, $\prod$= Net returns (Tk./ha);

Q_y = Total quantity of (paddy) output (kg/ha);

P_y = Per unit price of (paddy) output (Tk./kg);

Q_b = Total quantity of the concerned byproduct (kg/ha);

P_b = Per unit price of the relevant byproduct (Tk./kg);

X_i = Quantity of the concerned i^{th} input;

P_{xi} = Per unit price of the relevant i^{th} input;

TFC = Total fixed cost involved in production process;

$i = 1,2,3,...,n$ (Number of inputs)

Results and Discussion

Data in table 28 revealed that the average education years of contract growers were higher than the non-contract growers as BADC tends to select quality farmers emphasizing on farming experience, knowledge about rice farming, and level of education. The average farm size of the contract growers

and the non-contract growers was 1100 decimals and 272 which justifies that BADC select farmers with more cultivable land.

Table 28. Demographic profile of the selected seed growers in the study area

Particulars	Contract growers	Non-contract growers
Family size (no.)	5	5
Age (year)	45	49
Experience (years)	24	27
Education (years)	10	8
Farm size (decimal)	1100	272
Annual Income (Tk/yr)	7,06,897	2,91,500
Occupation (%)		
Agriculture (%)	87	90
Business (%)	7	10
Service (%)	6	0

Source: Field Survey, 2022

Contract growers used more human labor as they had to do the intercultural operations (i.e., weeding, roughing, perching etc.) more intensively in contrast to non-contract growers in both the season. Moreover, having significantly larger farm sizes, CGs used more hired labor than the non-CGs. CGs used less seeds than the non-CGs in Boro and Aman seasons by 1 kg/ha and 6 kg/ha (Table 29). To cultivate one acre of land CGs depends on BADC, but non contract growers buy private company seed.

Table 29. Input use pattern of seed growers in Boro and Aman season

Input Items	**Boro**		**Aman**	
	Contract growers	Non-contract growers	Contract growers	Non-contract growers
Seedling age (days)	32	30	28	30
Transplanting date	20 Nov-15 Jan	10 Nov-05 Feb	10 June-01 Aug	16 June- 10 July
Human labor (man-day/ha):	163	159	175	149
Hired	47	34	28	43
Family	11	27	22	28
Hired contract	105	98	124	78
Seed (kg/ha)	27	28	27	33
Fertilizer (kg/ha):	833	981	775	860
Urea	307	349	324	303
TSP	170	183	168	165
MoP	140	165	136	134
DAP	114	129	89	116
Gypsum	86	141	45	128
ZnSo4	16	15	13	14
Sulphur	37	52	39	57
Magnesium	18	15	17	37

Source: Field Survey, 2022

Per hectare human labor cost by contract growers was 81,671 Tk and it was 79,446 Tk for non-CGs in Boro season. In Aman season, per hectare human labor cost was Tk 87,339 for CGs while it was Tk 74,670 for non-CGs. Per hectare human labor cost of CGs in both the seasons was higher due to dependency on hired labor and reluctance to use family labor. In both Boro and Aman seasons, fertilizer cost by non CGs was higher than the CGs. Total cost of contract growers and non-contract growers was Tk 2,05,237 and 2,07,054 respectively in Boro season while in Aman season it was Tk 1,94,965and Tk 1,80,018 respectively (Table 30).

Table 30. Input-wise per hectare cost in Boro and Aman season

Input-wise cost (BDT/ha)	**Boro**		**Aman**	
	Contract growers	Non-contract growers	Contract growers	Non-contract growers
Seed	1581	2619	1595	2428
Seedling development	950	800	750	897
Land preparation	10007	11318	12599	10169
Human labour:	**81671**	**79446**	**87339**	**74670**
Hired	23511	17236	14216	21653
Family	5659	13289	11123	14096
Hired contract	52500	48922	61999	38921
Fertilizer cost	23003	25789	21403	25689
Irrigation	15626	18733	9117	7884
Pesticide:	11788	9724	10846	7228
Herbicide	1489	1211	1334	1095
Insecticide and fungicide	10299	8512	9512	6133
Power thresher	5509	3629	3849	3917
Total variable cost	**144475**	**138769**	**136376**	**118785**
Interest on operating capital	2709	2602	2557	2227
Land rent	52394	52394	44909	44909
Total fixed cost	60762	68285	58589	61233
Total cost	**205237**	**207054**	**194965**	**180018**

Source: Field Survey, 2022

Per hectare yield of CGs in Boro season was 6,768 kg and non-CGs was 6,917 kg. In Aman season, CGs per hectare yield was 5,645 kg while it was 5,579 kg for non-CGs. Gross margin for CGs in both the season was higher than the non-CGs. Price of per kg rice seed is determined by BADC in case of CGs after analyzing the costs and market price that's why CGs unit price is higher in both the seasons in comparison to non-CGs. Benefit cost ratio (full cost basis) was 1.56 for CGs and 1.31 for non-CGs in Boro season while benefit cost ratio (full cost basis) was 1.38 for CGs and 1.07 for non-CGs in Aman season (Table 31).

Table 31. Level of profitability in rice seed production by selected growers

Items	**Boro**		**Aman**	
	Contract growers	Non-contract growers	Contract growers	Non-contract growers
Total costs (BDT/ha)	205237	207054	194965	180018
Total variable costs (BDT/ha)	144475	138769	136376	118785
Total fixed cost (BDT/ha)	60762	68285	58589	61233
Yield (kg/ha)	**6768**	**6917**	**5645**	**5579**
Market value of paddy (BDT/ha)	291018	228263	231438	156204
Market value of straw (BDT/ha)	28520	43544	36749	36801
Gross benefit (GB) (BDT/ha)	319538	271807	268186	193004
Gross margin (GM) (BDT/ha)	175063	133038	131811	74219
Gross profit ratio (GM*100)/GB	54.79	48.95	49.15	38.45
Net return (BDT/ha)	114301	64753	73221	12986
Unit price of grain (BDT/kg)	43	33	41	28
Cost of production (BDT/kg)	30.33	29.93	34.54	32.27
BCR (cash cost basis)	**2.21**	**1.96**	**1.97**	**1.62**
BCR (full cost basis)	**1.56**	**1.31**	**1.38**	**1.07**

Source: Field Survey, 2021

Major constraints faced by the contract growers enlisted in table 32 from which it is evident that unavailability of labor, high disease and insect infestation, and high wage rate of labor were the prime problems in the study area. Almost half the respondents considered the unavailability of labor as prime constraint and due to the unavailability of farming labor, wage rate also become higher in the peak season (Table 32).

Table 32. Constraints of rice seed production

Constraints	**% of respondents**
Unavailability of labor	52
High disease and insect infestation	45
High wage rate of labor	34
Drying and grading cost high	21
High price of insecticides	13
High irrigation cost	8

Source: Field Survey, 2022

Conclusion

To get maximum rice production in the country, good quality seed is mandatory. Seed production through contract growers can be a good source for quality seed. Rice seed production is also profitable for contract growing farmers. So, the number of contract growers can be increased to ensure quality seed to the farmers.

PROGRAM AREA-III: RICE MARKETING AND PRICE POLICY

STUDY 1: SPATIAL PRICE DYNAMICS OF RICE IN BANGLADESH: AN EVIDENCE FROM TIME-SERIES ANALYSIS

L Deb and MS Islam

Introduction

Rice has a vast market in terms of both volume and participants that often remains at the center of controversy in Bangladesh. Bangladeshi rice market is characterized by a plenty of intermediaries who maneuver along the vertical and spatial supply chain. Therefore, integrity and efficiency of rice markets are prime concern in the rice sector of the country. Again, market integration, price transmission and volatility analysis have been considered as the effective signaling mechanisms to determine market efficiency by the economists. Policy makers also possess keen interest on these issues for accordingly devise policies and strategies as these are the evidences from macro-economic aspects. Thus, this study aims to evident the pricing irregularities exist in the spatially separated rice markets for finding a way toward sustainable rice value chain in Bangladesh. The specific objective of this study is-

- to analyze short-run and long-run spatial price relationships including market integration, price transmission and volatility among 12 major wholesale rice markets in Bangladesh.

Methodology

Time-series data from secondary source has been used for the study. Weekly average wholesale price series of 12 major rice markets namely, Barisal, Chattogram, Dhaka, Khulna, Kushtia, Mymensingh, Naogaon, Rajshahi, Rangpur, Sherpur, Sunamganj and Sylhet were considered for this study. Price series covering the period 2012-2020 were considered and collected from the Department of Agricultural Marketing (DAM), Ministry of Agriculture, Government of the People's Republic of Bangladesh. Johansen co-integration model, Vector Error Correction model (VECM) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model were used for analyzing market integration, price transmission and volatility clustering, respectively. EViews 10 along with updated add-ins were used as analytical software.

Stationarity Test

Unit root tests were done by Augmented Dickey-Fuller (ADF) test whereas rank of co-integration was identified using Johansen co-integration test. The ADF test is one of the utmost frequently used tests for stationarity. It tests the null hypothesis of the existence of unit root i.e., the ADF tests for the null hypothesis of non-stationarity against the alternative hypothesis of stationarity condition. Rejection of the null hypothesis assures the stationary condition in the respective series. The ADF consists of estimating the following regression:

$$\Delta y_t = \beta_1 + \beta_2 + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_1 \Delta y_{t-1} + \varepsilon_t \qquad (1)$$

Where ε_t is a pure white noise error term which is independently and identically distributed as a normal distribution with zero mean and constant variance and is assumed to be homoscedastic, $\Delta y_{t-1} = (y_{t-1} - y_{t-2})$, $\Delta y_{t-2} = (y_{t-2} - y_{t-3})$ etc. (Dickey and Fuller, 1979). *m* is the number of lags which are included in the model to ensure that the residuals ε_t have zero mean and constant variance.

The ADF, therefore, tests the null hypothesis that $\delta = 0$; that is the variable in question comprises a unit root *i.e.*, non-stationary in contradiction of the alternative that $\delta < 0$ that is, the time series is stationary. The actual estimation procedure of the ADF test is to difference a variable and regress it on its lagged value e.g., $\Delta y_t = \delta y_{t-1} + \mu_t$. Then divide the estimated coefficient of Δy_{t-1} by its standard error to compute the *t* (tau) statistic, and refer to the DF tables. If calculated tau statistic is greater than the MacKinnon critical tau values, the null hypothesis that $\delta = 0$ is rejected. On the other hand, if the

computed absolute value of tau is not greater than the critical tau value, we fail to reject the null hypothesis that the time series is non-stationary (Gujarati and Sangetha, 2007).

Modeling Co-integration Relationship

The first objective of the study was to analyze short-run and long-run vertical price relationships among farm, wholesale and retail rice markets in Bangladesh. If ADF and PP test confirm that the series are integrated at the same order i.e. I (1), the next step is to test for cointegration of price series. Johansen Maximum Likelihood (1988) technique was employed to test for cointegration as the model has specific advantages over other traditional regression methods. The model, unlike the Engel-Granger method, can accommodate more than two price series in analysis. Using this test, the study was able to determine how many cointegrating relationships existed between different markets. Johansen procedure helps to determine and identify the cointegrating vectors. The number of cointegrating vectors should be less than the number of variables. In vertical supply chain, as we are dealing with three distinct price series and thus, the number of cointegrating vectors should be less than three that is $0 \leq r \leq 3$.

Two statistics, namely eigenvalues and trace statistics are used in the Johansen test. This is a maximum likelihood ratio test involving a reduced rank regression between two variables, say I(0) and I(1) providing an *n* eigenvalues $\hat{\lambda}_1 > \hat{\lambda}_2 > \ldots\ldots\ldots \hat{\lambda}_n$ and corresponding eigenvectors $\hat{v} = (\hat{\vartheta}_1, \ldots\ldots, \hat{\vartheta}_n)$, where the r elements of $\hat{v}$ are the cointegration vectors. The magnitude of λ is a measure of the strength of the correlation between the cointegrating relations for i = 1…r. The trace statistic tests the null hypothesis of r cointegrating vectors against the alternative of r +1. The maximum eigenvalue statistic tests the null hypothesis of r = 0 against the alternative of r =1. The null hypothesis that there are r cointegrating vectors can be stated as follow:

H_0: $i_f = 0$ i = r+1……., n

The maximum eigenvalue statistic (λ_{max}) is given by-

$$\lambda_{max} = -T \ln (1 - \hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots\ldots., n-1 \qquad (2)$$

Where T is the sample size and $(1-\hat{\lambda}_{r+1})$ is the maximum eigenvalue estimate.

The trace statistic is computed as:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_i) \quad r = 0, 1, 2, \ldots\ldots., n-1 \qquad (3)$$

Both tests consider the null hypothesis that there are maximum *r* co-integrating vectors and the procedure for determining the number of co-integrating vectors follows a sequential procedure. First, the null hypothesis H_0 ($r = 0$) against alternative hypothesis $H_1(r \geq 1)$ is tested. If this null is not rejected then it is concluded that there are no cointegrating vectors among the *n* variables. If H_0 ($r = 0$) is rejected then it is concluded that there is at least one co-integrating vector and the process proceeds to test H_0 ($r \leq 1$) against $H_1(r \geq 2)$. If this null is not rejected then it is concluded that there is only one co-integrating vector. The criterion of estimating the number of cointegrating equations is to accept the first cointegration rank, *r* for which the null hypothesis is not rejected.

Later, Granger causality and Vector Error Correction Model (VECM) were applied to find the price leadership and extent of price adjustment among the markets, respectively.

Modeling Price Relationships in Vector Error Correction Model (VECM)

If cointegration has been detected between series we know that there exists a long-term equilibrium relationship between them so we apply VECM in order to evaluate the short run and long run properties of the cointegrated series. In case of no cointegration VECM is no longer required and we directly precede to Granger causality tests to establish causal links between variables. The regression equation form for VECM is as follows:

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \Sigma_{i=0}^{n} \beta_i \Delta Y_{t-i} + \Sigma_{i=0}^{n} \partial_i \Delta X_{t-i} + \Sigma_{i=0}^{n} \varphi_i \Delta Z_{t-i} \qquad (4)$$

$$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \Sigma_{i=0}^{n} \beta_i \Delta Y_{t-i} + \Sigma_{i=0}^{n} \partial_i \Delta X_{t-i} + \Sigma_{i=0}^{n} \varphi_i \Delta Z_{t-i} \qquad (5)$$

In VECM the cointegration rank shows the number of cointegrating vectors. For instance, a rank of two indicates that two linearly independent combinations of the non-stationary variables will be stationary. A negative and significant coefficient of the ECM (i.e., e_{t-1} in the above equations) indicates that any short-term fluctuations between the independent variables and the dependent variable will give rise to a stable long run relationship between the variables.

Generalized Autoregressive Conditional Heteroscedasticity (GARCH) Model

$$\text{GARCH (p, q): } h_t = \varphi + \Sigma_{k=1}^{p} \Theta_k \, h_{t-k} + \Sigma_{i=1}^{q} b_i \, \mu^2{}_{t-i}$$

Which says that the conditional variance (h) at time *t* depends both on the past values of the shocks captured by the lagged squared error term ($\mu^2{}_{t-i}$) and past values of itself (h_{t-k})

Results and Discussion

Table 33 represents the descriptive statistics regarding the weekly average wholesale price of rice of 12 studied markets during 2012-2020. Highest average price (38.68 Tk/kg) was observed in Dhaka while lowest (36.24 Tk/kg) was in Chattogram market during the study period. Dhaka and Rangpur market experienced the maximum price (54.50 Tk/kg) whereas minimum price was found at Kushtia (20.28 Tk/kg) during 2012-2020.

Table 33. Descriptive Statistics of Spatial Rice Prices (Tk/kg)

	Barisl	Chattogram	Dhaka	Khulna	Kushtia	Mymensingh	Naogan	Rajshahi	Rangpur	Sherpur	Sunamganj	Sylhet
Mean	38.34	36.24	38.68	36.40	36.58	38.18	37.17	37.61	37.17	36.90	37.53	36.61
Median	37.66	35.00	37.30	35.16	35.68	37.85	36.75	36.41	36.93	37.00	37.50.	36.33
Max.	50.00	49.33	54.50	51.33	53.00	53.25	50.16	50.83	53.62	54.50	50.75	52.08
Min.	29.00	24.20	31.00	25.33	20.28	26.75	22.83	27.41	25.43	26.75	22.00	26.83
Observ.	471	471	471	471	471	471	471	471	471	471	471	471

Table 34 exemplifies the results obtained from Johansen co-integration test. For the multivariable model, the co-integration test is by using Johansen's maximum likelihood procedure based on two test statistics, namely, the trace and eigenvalue. The results of both Trace and Maximum-eigen statistic indicate the rejection of no co-integration as well as at least seven co-integrating equations among the 12 markets. This result implied that all the studied 12 major wholesale markets are co-integrated in long-run. The price of those markets may vary to a different level in the short-run but they are expected to move together as a system in the long-run during the study period. This necessitated the estimation of the movement of price in the long-run and short run, using VECM.

Table 34. Estimation of Spatial Co-integration by Johansen Co-integration Test

Co-integration Rank (*r*)	Test Statistic			
	λ_{trace}	λ_{trace} (95%)	λ_{max}	λ_{max} (95%)
H_0: $r = 0$ vs $H_1 = r \leq 1$	417.13***	285.14	74.65***	70.53
H_0: $r \leq 1$ vs $H_1 = r \leq 2$	342.48***	239.23	68.86**	64.50
H_0: $r \leq 2$ vs $H_1 = r \leq 3$	273.62***	197.37	60.27**	58.43
H_0: $r \leq 3$ vs $H_1 = r \leq 4$	213.35***	159.53	57.40**	52.36
H_0: $r \leq 4$ vs $H_1 = r \leq 5$	155.95**	125.61	43.90*	46.23
H_0: $r \leq 5$ vs $H_1 = r \leq 6$	112.05**	95.75	37.64*	40.08
H_0: $r \leq 6$ vs $H_1 = r \leq 7$	74.41**	69.82	28.25	33.88
H_0: $r \leq 7$ vs $H_1 = r \leq 8$	46.15	47.86	21.84	27.58

NB: *, ** and *** denote rejection of hypothesis at 0.10, 0.05 and 0.01 level, respectively

Table 35 demonstrates the results obtained from Granger causality test. This implies that price of Dhaka market leads the price of Sunamganj, Naogaon and Chattogram in long-run during the study period whereas, Khulna leads Naogaon, Sherpur, Sunamganj and Chattogram market. Except those unidirectional relationships stated in the Table 35, all other market pair shows bidirectional relationships during the study period.

Table 35. Granger Causality Test Result

Causality Direction	
Dhaka Granger Causes Sunamganj	Naogaon Granger Causes Chattogram
Dhaka Granger Causes Naogaon	Kushtia Granger Causes Sylhet
Dhaka Granger Causes Chattogram	Kushtia Granger Causes Chattogram
Khulna Granger Causes Naogaon	Rajshahi Granger Causes Dhaka
Khulna Granger Causes Sherpur	Sherpur Granger Causes Rajshahi
Khulna Granger Causes Sunamganj	Sunamganj Granger Causes Rajshahi
Khulna Granger Causes Chattogram	Barisal Granger Causes Sherpur
Naogaon Granger Causes Rajshahi	Chattogram Granger Causes Sunamganj

Table 36 represents the results of price transmission among 12 spatially separated major wholesale markets obtained from VECM. It is evident from the table that Dhaka market shows poor adjustment to the price change in all the other 11 wholesale markets across the country in long-run. It is to be noted that all the error correction terms (ECT) are negative and significant which confirm the convergence of all the markets in long-run i.e., the price of these markets may vary at short-run but they show convergence to the equilibrium in long-run. The highest ECT has been observed in case of Dhaka-Kushtia which is also lower in efficient market context, implies that Dhaka market adjust only 11% of price change in Kushtia market within a week.

Table 36. Estimation of Price Transmission by VECM

Market Pair	**ECT**	**t-Statistic**
Dhaka-Barisal	-0.0440*	-1.80740
Dhaka-Chattogram	-0.0385**	-2.03543
Dhaka-Khulna	-0.0925***	-4.12671
Dhaka-Kushtia	-0.1162***	-4.28634
Dhaka-Mymensingh	-0.0743***	-3.82864
Dhaka-Naogaon	-0.0312*	-1.86980
Dhaka-Rajshahi	-0.0784***	-3.78228
Dhaka-Rangpur	-0.0589***	-3.00645
Dhaka-Sherpur	-0.0428**	-2.44658
Dhaka-Sunamganj	-0.0178	-1.22791
Dhaka-Sylhet	-0.0214	-1.01816

NB: *, ** and *** indicates significance at 10%, 5% and 1% level, respectively

Table 37 signifies the result of GARCH (1,1) estimation of rice prices in 12 studied markets for analyzing the volatility scenario. All the constant terms in the equations are significant at 1% level which implies that the price of rice in all the individual market is dependent on the immediate past price of the respective market and a constant term. Moreover, the extent of volatility was found higher and persistent in Barisal market as the GARCH term is highest and the sum of residual term and GARCH term (0.97) tends to 1 in that case. All the wholesale rice markets except Kushtia showed high extent of volatility as all the GARCH terms are significant and much higher.

Table 37. Results of the GARCH Model for Volatility Clustering

Market	Constant	RESID(-1)^2	GARCH
Dhaka	0.000201***	0.181281***	0.444299***
Barisal	3.71E-05***	0.178893***	0.792584***
Chattogram	0.000178***	0.167357***	0.407102***
Khulna	0.000133***	0.211842***	0.598653***
Kushtia	0.000592***	0.704080***	-0.025326
Mymensingh	0.000221***	0.307628***	0.543562***
Naogaon	0.000234***	0.067776***	0.734968***
Rajshahi	9.62E-05***	0.172274***	0.667259***
Rangpur	0.000251***	0.239777***	0.608500***
Sherpur	0.000223***	0.163700***	0.643302***
Sunamganj	2.24E-05***	-0.029093***	1.012654***
Sylhet	0.000140***	0.090655***	0.748819***

NB: *, ** and *** indicates significance at 10%, 5% and 1% level, respectively

Conclusion and Recommendations

Though the studied major domestic wholesale markets across the country are co-integrated in long-run but that does not allow us to consider this system as an efficient one because of the presence of poor price transmission and high volatility in recent periods. Effective government intervention i.e., estimating demand and supply precisely, act with vibrant rules & regulations, effective import and procurement policies, assist in commercialization etc. might play important role in that case. Processors and Wholesalers should have brought under some regulations to refrain them from manipulating the market, and minimum support price should be introduced. Market infrastructure should be developed more- Introduction of rice processing centers; central wholesale market or reference market could be probable solutions. Connectivity among spatially separated rice markets should be improved more by well-developed transportation systems. Commercialization of rice farms should be encouraged and market monitoring should be strengthened more.

STUDY 2: RESILIENCE OF RICE VALUE CHAINS IN JASHORE: RECENT TRANSFORMATION AND VULNERABILITIES

A Chowdhury, L Deb, SMMH Noman, SA Jui and MS Islam

Introduction

Resilience of value chain is the capacity of a value chain to continue and develop in the face of disturbances, through the preparation for, response to and recovery from unexpected shocks and adaptation to ongoing change (Vroegindewey and Hodbod, 2018). The present study aimed at measuring the effect of various recent transformations and disturbances in region- specific rice value chains every year.

Objectives

- to revisit rice value chains in the face of recent transformations and disturbances in Jashore region
- to scrutinize the resilience and vulnerabilities of the rice value chain actors.

Methodology

Study Area:

The purpose of the study was to understand the rice value chain operations in Jashore region of Bangladesh. As a continuation of previous years' study, Jashore region was picked purposively to obtain some contrasting scenario of value chain operations where concentration of rice processing mills was comparatively low.

Sampling technique:

A total of 70 sample farmers and 45 different market actors were interviewed with structured questionnaires in June, 2022. To get the data, interviews were conducted with key informants in the value chain as well. Upstream in the value chain, 2 upazila of Jashore district with lower concentration of paddy processors were selected. Two villages from each upazila were randomly selected and 15-20 farmers were chosen who had sold a considerable amount of paddy in the last season.

Group discussion was conducted with village traders and paddy *Aratdars* who buy from farmers or other traders (12 in total). In addition to that, 10 traders were interviewed from district level main paddy markets of Jashore. Also, in midstream, 10 millers from Jashore, Chuadanga and Jhinaidaha districts were interviewed. Detailed surveys were conducted, focusing on information related to purchases, sales, and milling patterns with 5 automatic mills, 2 semiautomatic mills, 2 small husking mills and 1 grain sorting service provider. Sonali trader, one and only rice *Aratdar* is found operating in the Jashore region. 12 rice wholesaler and retailers from three main markets were also interviewed.

Collected data were feed into qualitative understanding in mapping the value chain and measuring resilience to changes and financial losses.

Result Discussion

Different types of traders were found in the study areas during the field survey; namely input dealer, farmers, *Faria*, *Bepari*, *Aratdar*, agent of rice miller, commission agent, grain-sorting service provider, rice *Aratdar*, by-product buyers, wholesaler and retailer. The sample traders include *Bepari*, paddy *Aratdar*, input dealer, grain-sorting service provider, agent of rice miller, rice millers (husking, semi and auto), rice *Aratdar*, wholesaler and retailer.

Value Chain Structure

The overall findings showed that, at the upstream of the value chain in general, farmers mostly market their products within two months of harvesting with the help of *Bepari* and *Aratdar*. The nature of operation and roles of *Bepari, Aratdar* and commission agent were found frequently changed depending on the agreement with rice mills and availability of paddy in peak and off-peak season. They were used to store paddy for short period of time to catch a good price

Respondent farmers were asked to differentiate value chain structure and approaches of traders in context of good price, bumper production, normal market conditions and that of distorted market conditions in recent years. Finding showed that, although the chain remained more or less the same, in many cases traders came to the doorsteps of farmers and bear the paddy transportation costs when the price notion was comparatively high. On the other hand, in the years of unfair farm prices the farmers had to pay visits to local markets with paddy samples and match the quality requirements.

Traditional rice value chain was confined in the rural area. It was the local supply of paddy grown by the subsistent farmer, de-husked in a local mill, and consumed by the farm household or sold to the nearby market for local consumption. Semi-auto mills were rarely found in the study area. In the midstream of rice value chains, some consumers' demand-driven operation and changes were recorded. Traditional husking mills and semi-auto mills mainly process paddy by single parboiling. They were commonly found to take the service of sorting mills for further sorting, whitening and polishing of the grains.

Surveyed auto-rice mills were found collecting paddy mainly from adjacent districts. Cultivation of bold grain was comparatively low at Jashore region. To fulfill the government contract of providing rice for procurement program, they collected bold grains from other regions of the country. *Aratdar* and commission agents directly sent paddy to auto-mills (with prior contact or just informing over phone) at a price set by the millers. These traders charged the upstream actors (like farmers and *Bepari*) at the same rate maintaining own profit.

The study result showed that, downstream rice value chain was characterized by a traditional approach that entailed the rice traders (like *Aratdar*, wholesalers, retailer) buying from indirect sources rather than buying directly from mills. Personal contact and mobile communication with auto-rice millers giving a specification of rice grain was the key action. A giant trading company was doing monopoly business alone in the study area as rice *Aratdar*. It collected rice both from local mills and from other regions like Kushtia. It had a strong network of dealership. At the bottom of the value chain wholesale market traders sell the rice finally to the retailers.

Longest and shortest rice value chains that connected large geographical areas are mentioned below:

<u>Lengthiest Value Chain</u>

Farmer ⟹ *Bepari* ⟹ Paddy *Aratdar-cum-commission agent* ⟹ Miller (Semi-auto) ⟹ Grain-sorting service provider ⟹ Miller (Semi-auto) ⟹ Rice *Aratdar* ⟹ *Aratdar*-cum-wholesaler ⟹ Retailer ⟹ Consumer

<u>Shortest Value Chain</u>

Farmer ⟹ *Aratdar* ⟹ Miller (Auto-mill) ⟹ Rice *Aratdar* ⟹ Retailer ⟹ Consumer

Resilience and vulnerabilities of the rice value chain actors

Sample value chain actors were asked about major problems faced in recent years without referring any specific biophysical or market calamities. They were asked to rank the phases of rice value chain according to risks and vulnerability.

Resilience of Farmers

All the farmers refered to yield and price as the most vulnerable aspect (Table 30). In their words, other aspects and value chain phases were smooth and uninterrupted. They reported that, all the inputs, labour and transportation facilities were available all over the year. High yielding varieties, diligent family labour, suitability of rice in the cropping patterns, practical knowledge and experience, growth-oriented mind set and willingness of farm households were strong pilers towards resilience. They commonly asked for government initiatives for improved farm mechanization, weather advisory and fair input pricing.

Farmers were questioned about their persistency in case of continued unprofitable rice farming. Most of the farmers reported that they would never completely stop cultivating paddy as it is essential for home consumption and fits best in the cropping pattern. Renting out comparatively less productive parcels of rice land was one of the coping strategies. Among all the actors in the rice value chain, farmers were found the most uncomplaining. They opined that, the losses in rice cultivation in mitigated by other farm and non-farm incomes which adversely affected household expenditure.

Table 38. Drivers of resilience for rice farmers and copping strategies

Value chain phase	***Vulnerability Rank***	***Drivers of resilience***	***Key disruptions towards vulnerability***	***Impacts of disruptions***	***Copping strategy***
Input acquisition	-	Easy access and availability of inputs in local market	• Artificial crisis • Paid higher prices • Visited multiple time as demand was high • Quality not assured	• Higher cost of production	• Buying in smaller quantity • Contact over mobile phone
Farming	1	• High yielding varieties • Cropping pattern suitability • Practical knowledge and experience • Diligent family labour • Extension service • Growth oriented mind set and willingness	• Bio-physical disruptions (Pest and disease) • Timeliness of prevention • Labour cost and low mechanization • Low return to investment	• Yield loss • Low productivity • Financial pressure and dependence on other income sources	• Consultation and experience sharing • Renting out rice lands • Shifting to other crops
Processing	3	• Mechanization • Diligent family labour	Dependence on weather	• Post-harvest loss • High moisture content and impurities • Lower grading and price degradation • Inefficiency	Early selling
Storing	-	• Easy to preserve for medium term • Personal arrangements	• Dependence on weather • Rats and insects	Inefficiency	Early selling
Transportation	-	Easy access and availability	High fare	Added cost of marketing	
Market Access and price	2	• Easy access to local markets • Personal contact with traders • Availability of price information	• Price volatility • Delayed payment by traders • Harassment in public procurement system	• No market power • Profit forgone	Belated selling

Resilience of paddy traders

Most of the respondents pointed that, financing and pricing was the most vulnerable phase, followed by storage, transportation. According to key informants, longer storage durability of paddy, unlike other commodities and vegetables, was the driver of resilience in the upstream of rice value chain. The study found that, the development of communication and transportation system and higher use of mobile phone served as a strength.

Resilience of rice millers

In the study area, rice mills were established in easily-accessible locations nearby highways. Most of the respondent auto rice millers belonged to influential families or were actively involved in local politics. Auto rice mills operated around 10 months a year as the paddy supply remained ample. They reported that, experienced and efficient workers and machine tools were locally available. High rate of interest and electricity bill were the key disturbances (Table 39).

Respondents were asked about their copping strategies in case of rice price distortion. They reported that, they coped up with losses by adjusting that with the next year's price.

Table 39. Drivers of resilience for auto rice millers and copping strategies

Value chain phase	***Drivers of resilience***	***Vulnerability, its impacts and copping strategy***
Financing	Easy access to institutional loan	Higher interest rate
Paddy acquisition	• Easy access and availability of inputs in local market • Strong local linkage	Moisture adjustment Low head rice recovery
Processing	• Automation • Range of by-products	Burden of operational cost
Storing	• Easy to preserve for medium term • Personal arrangements	Government watchdogged stocks and asked for weekly reports
Transportation	• Established in easily-accessible locations nearby highways • Own vehicles	-
Selling	• Strong client base • Personal contact with traders • Availability of price information • Integration and forward linkages	• Sudden removal of import restrictions alters market demand scenario and the profit declines • Dues and Arrears that resulted in financial burden
Pricing and market power	• Highest market power • Price setter	coped up with losses by adjusting that with the price of next year
Branding	• Brand practice and high profit margin	
Others	• Strong association among millers • Political involvement • Financial back-up	*Copping strategy:* Floor price antagonism

Conclusion

The overall findings showed that, value chain operation in general was lengthy and involved more actors. The farmers mostly market their products with the help of *Bepari* and *Arardar*. Farming operations were managed inefficiently depending on nature. Price of paddy was set in the midstream of rice value chains and storing paddy for short time was the only practice to get a good price at farm level. Local rice millers reported an inclusive use of sorting, whitening and polishing rice to acquire the expected grain qualities which had higher market demand. Furthermore, lesser evidence of transformation in rice value chain was found at downstream where a single trading company was controlling the wholesale market alone.

The resilience of the rice value chain was found financed by the actors themselves. Farmers referred to price and bio-physical disruptions in farming as the most vulnerable aspects while the traders and millers referred to financing and changes in pricing policies. Farmers coped adversities of rice cultivation by accumulating resources from non-rice and non-farm sectors. On the other hand, traders and millers coped with losses by increasing the rice price of the following years.

STUDY 3: MARKET CONCENTRATION OF POPULAR RICE BRANDS IN BANGLADESH

MC Rahman, MAR Sarkar, MS Rahaman, MA Islam, and MS Islam

Introduction

Rice is a major dietary food for more than fifty percent of the world population and accounts for more than twenty percent of caloric intake. Available literatures demonstrate that with economic progress and growth in the disposable income of households, income elasticities for rice are becoming smaller over time. This has led to a decline in per capita rice consumption in a number of high- and middle-income countries. There is evidence that an increase in consumer income led to more consumption of fine-grain rice by replacing ordinary-grain rice, with declining total rice consumption. The rice market in Bangladesh is rich in fine rice with some popular brand names. The most popular names are Minikit, Nazir, Katari, Zira, BR28, etc. Bangladesh is not producing the paddy of these brand names as much as the amount of clean rice found in the market. Some newspapers reported that over-polishing of medium-bold grain is the mechanism of manufacturing fine rice grain in the auto rice mills. Therefore, this study is designed to identify the available rice brands in Bangladesh and their market concentration.

Objectives

- to identify different types of rice brands available in the market; and
- to assess the level of concentration of the popular rice brands in the Bangladesh rice market.

Methodology

Location and sample size

This study surveyed 20 Upazilas from 10 districts and seven city markets in Bangladesh. The Upazila markets have been selected by consultation with the respective district-level Department of Agricultural Extension and the Department of Marketing offices. Rice wholesalers/Aratdar and retailers are surveyed to estimate the market share and concentration of different rice brands in the Upazila and city markets. The distribution of sample size according to the value chain actors is presented below.

Sample size of the rice value chain actors

Actors	Sample size		
	Upazila market	City market	Total
Rice Wholesaler/Aratdar	20*15=300	20*7=140	440
Rice Retailer	20*20=400	20*7=140	640

Sampling technique

This study employed a stratified random sampling technique to select the respondents from the rice markets. The rice traders are classified into large, medium, and small. The sample size is distributed proportionally according to the population of respective traders' classes in the markets. Data were collected through a structured interview schedule from May to August 2021.

Location

Tweenty Upazila markets of Sunamgonj, Netrokona, Mymensingh, Jamalpur, Bagura, Dinajpur, Naogaon, Kustia, Jashore, Cumilla and Kurigram districts and seven city markets from the seven city corporations (only except Barishal of eight city corporations in Bangladesh).

Empirical approach

The Herfindahl Index measures the size of firms or brands in relation to the industry or sector and indicates the amount of competition among them. It is named after economists Orris C. Herfindahl and Albert O. Hirschman. It is also known as Herfindahl–Hirschman Index, or HHI. An increase in the HHI generally indicates a decrease in competition and an increase in market power, whereas decreases indicate the opposite.

Results and Discussion

Market share and price of popular rice brands in the sampled Upazila markets

In the Upazila level markets, BR28 was the most popular rice brand contributing about 40% of the available rice, followed by Minikit (17.7%), Swarna (14.5%), BR29 (12.1%), Pajam (6.1%), Zira (3.1%), and Katari (2.4%) (Figure 4). Due to the quality and aroma, the average price of Chinigura was the highest (87.5 Tk/kg) in Upazila markets. The most popular BR28's price was 51 Tk/kg, whereas the price of Minikit was 58.5 Tk/kg. Nazir and Katari were fine-grain premium quality brands, reflecting relatively higher prices (60 and 58 Tk/kg, respectively) in the market. However, few consumers purchase these brands due to the low accessibility for higher prices (Table 40).

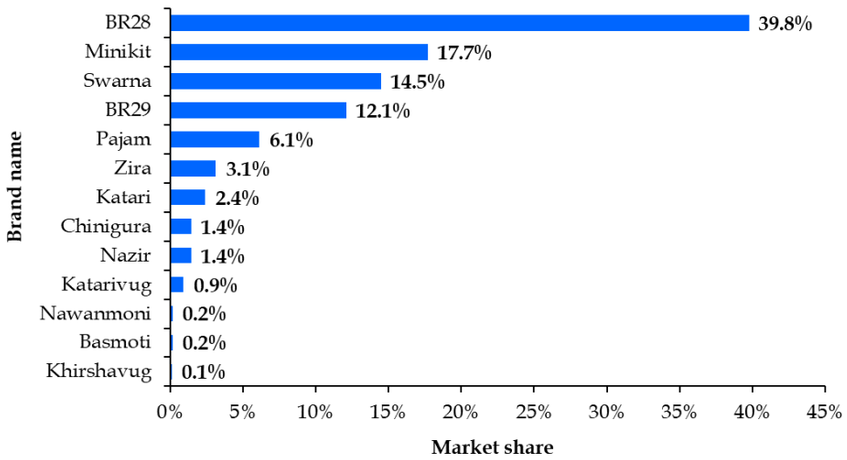

Fig 4: Market share of major rice brands in the surveyed Upazilas. Note: Prepared by the authors based on the information from the market survey during 2020-21.

Table 40. Price (Tk/kg) of available popular rice brands in the selected Upazila level markets in Bangladesh during 2020-21

Brand name	Price (Tk./kg)			
	Mean	Maximum	Minimum	Standard deviation
Khirshavug	66.5	71	62	4.5
Basmoti	63	66	60	3
Nawanmoni	47	49	45	2
Katarivug	61.5	64	59	2.5
Nazir	60	64	56	4
Chinigura	87.5	95	80	7.5
Katari	58	61	55	3
Zira	60	64	56	4
Pajam	47.5	49	46	1.5
BR29	48	50	46	2
Swarna	44	46	42	2
Minikit	58.5	62	55	3.5
BR28	51	54	48	3

Market share and price of popular rice brands in the sampled city markets

The most popular rice brand in the city markets was Minikit which shares 33.5% of the available rice brands, followed by BR28 (19.4%), Zira (19.2%), Nazir (8.5%), and Katari (5.2%) (Figure 5). Because of the aroma and premium quality characters, the price of Chinigura was the highest (102.5 Tk./kg) in the market. The price of Basmoti was 68.5 Tk per kg. The price of imported Basmoti ranged from 250-300 Tk per kg. The most popular Minikit's price was 60.5 Tk per kg, whereas BR28 and Zira were sold for 54.0 and 64.5 Tk per kg, respectively. The price of Nazir and Katari were 65.0 and 63.5 Tk/kg, respectively (Table 41).

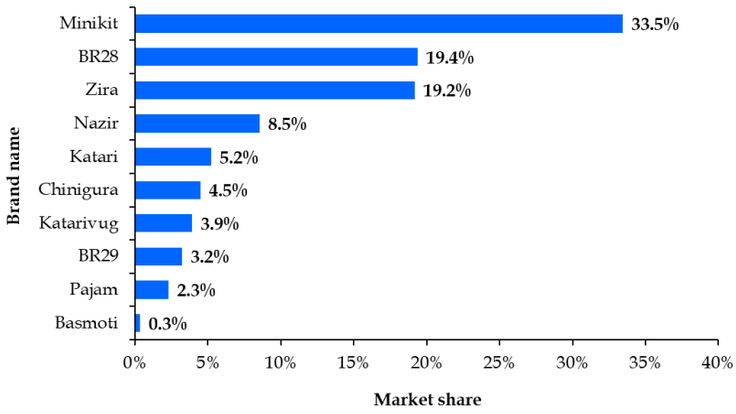

Fig 5: Market share of major rice brands in the surveyed cities. Note: Prepared by the authors based on the information from the market survey during 2020-21.

Table 41. Price (Tk/kg) of available popular rice brands in the selected city markets in Bangladesh during 2020-21

Brand name	Price (Tk./kg)			
	Mean	Maximum	Minimum	Standard deviation
Basmoti	68.5	72	65	3.5
Pajam	50	52	48	2
BR29	51	54	48	3
Katarivug	66.5	70	63	3.5
Chinigura	102.5	110	95	7.5
Katari	63.5	66	61	2.5
Nazir	65	68	62	3
Zira	64.5	67	62	2.5
BR28	54	56	52	2
Minikit	60.5	63	58	2.5

The market concentration of popular rice brands in Bangladesh.

The value of the HHI in the Upazila level markets was more than 1800, indicating that the concentration of rice brands in the Upazila markets was very high with very low competition. The market share of the top four was 97.33% (Table 42). That means the rice processors are highly concentrated on producing the top 4 brands.

Table 42. Popular rice brands on Upazila level markets.

Brand name	Market share (%)	S^2	HHI	Share of HHI (%)	CR4	CR4 shares of HHI (%)
BR28	39.76	1580.81	2319.97	68.14	2257.99	97.33
Minikit	17.89	320.07		13.80		
Swarna	14.50	210.15		9.06		
BR29	12.12	146.97		6.33		
Pajam	6.13	37.63		1.62		
Zira	3.23	10.43		0.45		
Katari	2.41	5.81		0.25		
Chinigura	2.35	5.52		0.24		
Nazir	1.61	2.58		0.11		

The value of the HHI indicates that the rice brands in the city markets were highly concentrated with low competition. The proportion of CR4 was 95.38% (Table 43). It means the rice processors are concentrated to produce the top 4 rice brands for the city markets of Bangladesh.

Table 43. Popular rice brands on city markets.

Brand name	Market share (%)	S^2	HHI	Share of HHI (%)	CR4	CR4 share of HHI (%)
Miniket	33.70	1135.69	1982.38	57.29	1890.75	95.38
BR28	18.90	357.21		18.02		
Zira	17.20	295.84		14.92		
Nazir	10.10	102.01		5.15		
Katari	6.70	44.89		2.26		
Chinigura	4.00	16.00		0.81		
Katarivug	3.90	15.21		0.77		
BR29	3.20	10.24		0.52		
Pajam	2.30	5.29		0.27		

Conclusion

This study is the preliminary finding of '*Tracking Rice Varietal Authentication in Bangladesh: A Pathway from Farm to Market*' where the varietal sources of existing rice brands will be figured out. The findings reveal that both Upazila and city markets were highly concentrated and the competition among the traders with rice brands was very low. The popular rice brands in Bangladesh are BR28, Minikit, Zira, Nazir, and BR29. The rice processors are highly concentrated to produce the top 4 brands that captured more than 95% share of the market. By the end of this study, the varietal sources of different rice brands and the causes of producing brandings would be identified.

PROGRAM AREA-IV: AGRICULTURAL POLICY AND DEVELOPMENT

STUDY 1: COMPARATIVE ADVANTAGE OF EXPORT POTENTIAL AROMATIC RICE (BRRI DHAN50) VARIETY IN SELECTED AREAS OF BANGLADESH

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Introduction

It is now commonly thought that Bangladesh may benefit from the commercial export of fragrant rice to gain important foreign currency. Even though the country has yet to develop a significant rice surplus, the case for exporting fragrant rice is compelling. The country will be able to earn foreign currency by exporting a specific amount of high-value fragrant rice. There have been intermittent attempts to export rice, with evidence of modest quantities of fragrant rice being exported to a number of places where nativars lived. However, whether or not a specific crop will be encouraged for production on a national/commercial level will be largely determined by analyzing its competitive advantage in the export or import substitution scenario.

For achieving sustainable aromatic rice production like BRRI dhan50 (*Banglamoti*) in *Boro* season, it is essential to investigate whether Bangladesh has a comparative advantage in *Boro* season aromatic rice (BRRI dhan50) production at import and export substitution in the short run. The specific objectives of the study were:

i) to examine the prospect of production of export potential aromatic rice (BRRI dhan50) variety in terms of import and export parity basis;
ii) to review of international standard for rice export and way-out the link to export policy; and,
iii) to draw some policy guidelines.

Methodology

Data

This study used cross-sectional data. A prominent aromatic rice-producing district namely, Jashore was selected purposively where BRRI dhan50 was grown specially. Two Upazilas (Sadar and Monirampur) from Jashore district, two Unions from each Upazila and two villages from each Union were selected purposively with the help of the Department of Agriculture Extension (DAE) personnel where the BRRI dhan50 producers were concentrated. A structured questionnaire was used to collect data from May to June 2021. A total of 160 farmers were chosen randomly after collecting a comprehensive list of BRRI dhan50 producing farmers in each village. For this study, we use only the data for BRRI dhan50 aromatic rice variety growing in the *Boro* season to achieve the set objectives.

The comparative advantage of rice-producing farms in Bangladesh

Usually, Policy Analysis Metrics (PAM), DRC ratio, Private Cost Ratio (PCR), and Effective Protection Coefficient (EPC) methods are useful in estimating the economic profitability of specific crops. Among these methods, the use of the DRC ratio is a convenient method of avoiding the problem of common numeraire, particularly when the production processes and outputs are very dissimilar. It serves as a proxy measure for social profits (Pearson et al., 2004). This method is a popular method for calculating the comparative advantage of a particular commodity. Therefore, this study employed the DRC ratio to measure the comparative advantage of export potential aromatic rice production at import substitution and export at export substitution in Bangladesh.

Data requirement for calculating DRC

A comprehensive data set is needed to estimate the DRC. The desired information required for constructing the DRC includes financial profitibility, market and social prices. For this study, we used cross-sectional data on the dry (*Boro*) seasons' costs and return of export potential aromatic rice (BRRI dhan50) and published and unpublished secondary data from different national and international sources. Inputs are divided into two categories: (1) traded intermediate inputs and (2) non-traded intermediate inputs.

Head rice recovery ratio is essential for calculating DRC value of aromatic rice import and export. First, we discussed with experts to consider a feasible head rice recovery ratio for BRRI dhan50. In this study, the head rice recovery ratio was considered 56% for the rubber huller machine and 52% for the angle-bar machine, respectively. In Bangladesh, when we use an angle-bar machine, the head rice recovery ratio stands at most 52%. However, when we use a rubber huller machine, the head rice recovery ratio stands at most 56% (Rahman et al, 2011).

Traded intermediate inputs

Traded intermediate inputs are either imported or exported. In Bangladesh, different fertilizers (i.e., Urea, TSP, MoP, gypsum, and ZnSo4), seeds, insecticides/pesticides, and machinery are usually used for rice production. Here, we consider these as traded intermediate inputs. The costs of tradable inputs are measured by social/border parity price. We use particular conversion factors of 0.914 for pesticide to construct a social budget (Shahabuddin and Dorosh, 2002). Although machinery costs are considered tradable input, no comprehensive data set is available to calculate the social/border parity price for this input at the farmers' level. Therefore, our study used market price as a border parity price.

Use of shadow price

The shadow price of seed is calculated by applying a well-adopted formula that has been used in the relevant analysis by Antriyandarti et al. (2012); Antriyandarti, (2015); Islam, (2016); Islam et al., (2021a); and Islam et al., (2021b). The formula is as follows:

$$Shadow\ seed\ price\ = \{(Actual\ seed\ cost/Actual\ output)\ \times\ Shadow\ output\ price\}$$

Non-traded intermediate inputs

Unskilled agricultural labor, manure, land rent, and interest on operating capital are considered non-traded intermediate inputs and domestic resources, because these components of the factors of production do not usually enter in the international market. Irrigation equipment is regarded as a non-traded intermediate input because detailed costs for irrigation equipment are unavailable. The fees of these inputs were collected from secondary sources (such as FPMU, 2020). The specific conversion factors are used for the social valuation of these costs and prices of non-tradable inputs. We use particular conversion factors of 0.85, 0.91, and 0.79 for human labor, manure, and irrigation charges, respectively to construct a social budget (Shahabuddin and Dorosh, 2002). However, this study uses manure and land rental costs as full social costs (Shahabuddin and Dorosh, 2002; BRF, 2005; Kazal et al., 2013). The opportunity cost of operating capital is calculated at 9% interest for five months of the rice production period in the *Boro* season. The payments for non-traded intermediate inputs and domestic resources are converted from a measurement of "*per unit of the land*" to "*per unit of output*". Methodologically, these items are valued considering their opportunity costs. In Bangladesh, factor markets are reasonably competitive; thus, payment for non-traded intermediate inputs and domestic resources represent the opportunity costs of these resources.

Estimation of domestic resource cost (DRC)

This subsection describes the methodology for estimating Bangladesh's global comparative advantage of MV rice production. As such, we use DRC as an indicator of international competitiveness, as Bruno (1972) suggested. The DRC is the ratio of the cost of domestic resources and non-traded inputs, valued at their shadow prices in producing the commodity domestically to the net foreign exchange earned or

saved through domestically producing the good. DRC measures whether a commodity is more profitable when produced domestically or importation is economical. DRC < 1 indicates that the commodity is more profitable when produced domestically; meanwhile, DRC > 1 suggests that it is less profitable to produce domestically. This criterion is used in this study to determine the economic profitability of rice production in Bangladesh in the *Boro* season and is estimated by using the following equation:

$$DRC_i = \frac{\sum_{j=k+1}^{n} a_{ij} p_j^*}{p_i^b - \sum_{j=1}^{k} a_{ij} p_j^b} \quad \ldots\ldots\ldots\ldots (1)$$

Where i = i^{th} farms, j = 1, ..., k are the traded inputs, j = k+1, …, n are the domestic resources and the non-traded intermediate inputs. p^*_j is the shadow price of domestic resources and non-traded intermediate inputs. p_i^b is the traded outputs border price, measured at the shadow exchange rate, and p_j^b is the border price of the traded input j, also measured at the shadow exchange rate.

Results and Discussion

Import parity basis:

The result of estimated DRC values on an import parity basis is presented in table 44 for the export potential aromatic rice BRR dhan50 in Bangladesh. In the import parity situation, when head rice recovery is 56 and 52%, then DRC values are 0.65 and 0.73, respectively. It means Bangladesh has comparative advantage for producing export potential aromatic rice like BRRI dhan50 at import substitution. These results are in line with the results of some earlier studies by Rashid (2009); Kazal *et al.* (2013; Tama et al, 2018). A plausible reason for these results is high prices of aromatic rice in the international market and higher per unit yield of aromatic rice in Bangladesh (Table 44).

Table 44. Domestic resource cost (DRC) of export potential rice variety (BRRI dhan50) in Bangladesh (Import parity basis).

Items	BRRI dhan50	
	Angle bar (Head Rice recovery ratio = 52%)	**Rubber Huller (Head Rice recovery ratio = 56%)**
A. Total tradable inputs (Tk./mt)	**8077.62**	**8077.62**
Urea	2091.49	2091.49
TSP	1203.73	1203.73
MoP	720.99	720.99
DAP	216.27	216.27
Gypsum	279.85	279.85
Znso4	119.01	119.01
Seed	1547.95	1547.95
Pesticide	586.56	586.56
Machinery charge	1311.79	1311.79
B. Total non-tradable inputs (Tk./mt)	**17562.01**	**17562.01**
Human labor	8805.01	8805.01
Manure	646.59	646.59
Irrigation	1868.54	1868.54
Interest on operating capital (IOC)	308.77	308.77
Rental value	5933.10	5933.10
C. Output price (Tk./mt)	32218.68	**34989.68**
D. DRC = (B/(C-A)	**0.73**	**0.65**

Export parity basis:

The results of estimated DRC values at export parity basis are presented in table 45 for the export potential aromatic rice like BRR dhan50 in Bangladesh. In the export parity situation, when head rice recovery is 56 and 52%, then DRC values are 0.91 and 1.06, respectively. When head rice recovery is 56%, Bangladesh has comparative advantage for export potential aromatic rice like BRRI dhan50 at export substitution. These results are in line with the results of some earlier studies by Rashid (2009);

Kazal *et al.* (2013; Tama et al, 2018). A plausible reason for these results is higher per unit yield of aromatic rice in Bangladesh. On the other hand, when head rice recovery is 52%, Bangladesh has no comparative advantage for exporting export potential aromatic rice like BRRI dhan50 at export substitution. It is important to note that, head rice recovery is important determinants for achieving comparative advantage both in import and export parity basis for the aromatic rice (Table 45).

Table 45. Domestic resource cost (DRC) of export potential rice variety (BRRI dhan50) in Bangladesh (Export parity basis).

Items	2020-21	
	Angle Bar (Head Rice recovery ratio = 52%)	**Rubber huller (Head Rice recovery ratio = 56%)**
A. Total tradable inputs (Tk./mt)	**8077.62**	**8077.62**
Urea	2091.49	2091.49
TSP	1203.73	1203.73
MoP	720.99	720.99
DAP	216.27	216.27
Gypsum	1547.95	1547.95
Znso4	279.85	279.85
Seed	119.01	119.01
Pesticide	586.56	586.56
Machinery charge	1311.79	1311.79
B. Total non-tradable inputs (Tk./mt)	**17562.01**	**17562.01**
Human labor	8805.01	8805.01
Manure	646.59	646.59
Irrigation	1868.54	1868.54
Interest on operating capital (IOC)	308.77	308.77
Rental value	5933.10	5933.10
C. Output price (Tk./mt)	**24580.74**	**27351.74**
D. DRC = (B/(C-A)	**1.06**	**0.91**

Minimum standard of commercial export potential aromatic rice varieties:

In size classification, BRRI dhan50 falls below the minimum international standard of long-grain (6.61 to 7.5 mm) whereas Jasmin type aromatic rice and Basmati type aromatic rice varieties fall within the long grain. In BRRI dhan50 and Jasmin type aromatic rice varieties, the elongation ratio is far less than the international standard whereas the Bashmati type aromatic rice varieties elongation ratio was higher than the minimum international standard. In addition, the amylose content of BRRI dhan50 does not fall within the minimum international standard. However, Jasmin-type aromatic rice varieties have lower amylose content. Some Bashmati type aromatic rice varieties have fallen within, and some are above minimum international standards of amylose content. BRRI dhan50 passes head rice recovery ratio, milling ratio, and aroma of minimum international standard (Table 46).

Table 46. Standards for evaluation of export potential aromatic rice grain (Physicochemical properties)

Items	Minimum Standard of commercial export (Bashmati type)	Minimum Standard followed (BRRI)	BRRI dhan50 (*Banglamati*)	Jasmin type aromatic rice	Bashmati type aromatic rice
Size classification:	**Length in mm**	**Length in mm**	**Length in mm**	**Length in mm**	**Length in mm**
Very long	>7.50	>7.50	-	-	-
Long	6.61 to 7.50	6.61 to 7.50	-	6.75 to 7.50	6.87 to 7.35
Medium or intermediate	-	5.51 to 6.60	6.60	-	-
Shape classification:	**Shape**	**Shape**	**Shape**	**Shape**	**Shape**
Slender	> 3.0	> 3.0	4.3	3.15 to 3.48	3.55 to 4.29
Volume of expansion	> 4 times	No standard but higher is better	3.4	3.15 to 3.48	3.50 to 3.8
Elongation ratio	>1.80	No standard but higher is better	1.2	1.39	1.82 to 2.02
Amylose (%)	20-22	>23	26.8	10.67 to 17.54	22 to 25
Head rice (%) (2% broken)	>40	>50	52 to 56	57.48	53 to 59
Milling (%)	>70	>66	69	-	67.7 to 75
Aroma	Strong	Present or absent	Strong	Strong	Strong
Color	Bright white	-	White	Bright white	Bright white

Conclusions and Recommendations

Bangladesh has a comparative advantage for producing export potential aromatic rice (BRRI dhan50) at import substitution. On the other hand, Bangladesh has a comparative advantage in exporting the likely fragrant rice like BRRI dhan50 at export substitution with head rice recovery at 56%. When head rice recovery has 52%, and below, BRRI dhan50 does not have a comparative advantage at export substitution. It means BRRI dhan50 rice production is not sustainable at export parity basis in Bangladesh.

In the size classification, BRRI dhan50 falls below the minimum international standard of long-grain (6.61 to 7.5 mm) whereas Jasmin type aromatic rice and Basmati type aromatic rice varieties fall within the long grain. BRRI dhan50 and Jasmin type aromatic rice varieties, the elongation ratio is far less than the international standard whereas the Bashmati type aromatic rice varieties elongation ratio was higher than the minimum international standard. Amylose of BRRI dhan50 does not fall within the minimum international standard. However, Jasmin-type aromatic rice varieties have lower amylose. Some Bashmati-type aromatic rice varieties have fallen within, and some are above minimum international standards of amylose content. BRRI dhan50 passes head rice recovery ratio, milling ratio, and aroma of minimum international standard. Finally, after considering the abovementioned minimum international standard of traits, BRRI dhan50 could not compete as aromatic rice trade commercially. It may compete only on government-to-government (G2G) contracts. Research efforts must be prioritized for developing new export potential Basmati type aromatic rice varieties incorporating the aforementioned required traits of international export aromatic rice breeding standards with high yield potential.

Appendix

Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022

Table A. Adoption (ha) of different Aus rice varieties by agricultural regions of Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
All HYV	**189456**	**41995**	**94027.9**	**97349**	**34076**	**39675**	**15294**	**147721**	**17366**	**27666**	**153453**	**3073.05**	**62190**	**172184**	**1095526**
All BINA Varieties	**1762**	**945**	**689**	**667**	**354**	**613**	**893**	**1362.5**	**423**	**1125**	**927**	**147.5**	**1386**	**3526**	**14820**
Bina dhan-10			110												110
Bina dhan-12												0.8			0.8
Bina dhan-14	7		120		5	2		169			150		220		673
Bina dhan-21		38		120		10	10	15		26	27		15	483	744
Bina dhan-22		80													80
Iratom	1107														1107
Bina dhan-11												1			1
Bina dhan-17									50			0.5			50.5
Bina dhan-19	648	753	459	547	349	601	882	936.5	373	1099	360	145.2	1151	3043	11346.7
Bina dhan-20							1				15				16
Bina dhan-7		74						242			375				691
All BRRI Varieties	**141244**	**37545**	**82863.9**	**83159**	**33274**	**28563**	**14323**	**98511**	**12228**	**26471**	**103952**	**2715.55**	**43946**	**166058**	**874853.5**
BR12	1308														1308
BR14	993	10			30				135	90		2	1214	2370	4844
BR16	236	210		355			6					4.65	325	160	1296.65
BR19					7									15	22
BR24		5										70		125	200
BR3	622			268						60	160	115		1410	2635
BR9												2			2
BRRI dhan29		20											440		460
BRRI dhan36		19													19
BRRI dhan37								3							3
BRRI dhan47			60												60
BRRI dhan50								148			35				183
BRRI dhan58				2206	182	1490		1505					505		5888
BRRI dhan63	35		5								9				49
BRRI dhan74								660			2	24	450		1136
BRRI dhan80											5				5
BRRI dhan81								77			375				452
BRRI dhan83	1032	5	637		130	241	427	169	164		1	3.75	25	1117	3951.75
BRRI dhan85	169	79	1044	3378	615	443		677	230.5	346	529	34.5	690	2128	10363
BRRI dhan89	2							8							10
BRRI dhan98			3	9				7		8				22	49
BR1		5										18		230	253
BR2	6406			4093	108				580						11187
BR20	1081			7932										255	9268
BR21	60	1875			36						3853			3065	8889
BR26	6158	2119		2472	1199	95	864	5391	1448	2101	1940	343	536	14532	39198
BR27	18401	767	7175	225			857		467			2		1709	29603
BRRI dhan28	50	3625	1486	11380	2240	12853	267	5536	729	869	17782	72	7108	14649	78646
BRRI dhan30							148								148
BRRI dhan33	165		59.9	335	70							130	115	87	961.9
BRRI dhan41										150					150
BRRI dhan42	1790	150	3227	110		90	520				130	150	723	2935	9825
BRRI dhan43	2257		2098	1925	15	97	1857	15		75		287	160	2512	11298
BRRI dhan44												67			67
BRRI dhan46												22	25		47
BRRI dhan48	94865	26113	48793	44283	27770	11654	6723	80870	7041	22135	70500	859	29926	108834	580366
BRRI dhan55	3252	890	16982	2817	233	582	1392	1105	922	70	3181	351	190	5436	37403
BRRI dhan56	10										4590		20		4620
BRRI dhan62								5							5
BRRI dhan65	212	386	96	3	36		675	5			160	59	207	632	2471
BRRI dhan75											100				100
BRRI dhan82	2140	1267	1198	1368	603	1018	587	2330	511.5	567	600	99.65	1287	3835	17411.15
All Hybrids	**360**	**505**	**4600**	**9936**	**418**	**9660**	**25**	**9847**	**1906**		**5022**	**50**	**16498**	**62**	**58889**
BRRI hybrid-2							5								5
BRRI hybrid-4							1								1
BRRI hybrid-7	198	3			87		6		15					4	313
ACI shera			563	861								50	150		1624
ACI-5													90		90
ACI-8								120							120
Aftab	10		97	20		35		38	185		210		35		630
Agmoni			40						0.2						40.2
Agro-14								321							321
Agro-4				140											140
Arize				15				565					40		620
AZ								220							220
Babylon-2				116		350		15					95		576
Balaka						30									30
Balia				703				14							717
Balia-2													800		800
Bizli				22											22
BRAC-777				200											200
Camist						60									60

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Chamak				123		117							273		513
Durbar			118												118
Gold			500	220			6								726
Hira		67	1228	1852				317	157				470	3	4094
Hira-1									30				10		40
Hira-2	12				144	811					215		2998		4180
Hira-4											100				100
Hira-5	50					464					105		946		1565
Hira-6						320			15		40		60		435
Ispahani			212	100		71		855					396		1634
Ispahani-2						1080		170					370		1620
Ispahani-7													40		40
Jagaron						80			40				110		230
Janakraj						220							431		651
Jhalak								20							20
KBP					19										19
Krishan								70							70
Krishibid		70													70
Lakpoti				45											45
Lal Tia								80							80
Lalteer						150		50					220		420
LP-106													20		20
LP-108					60										60
LP-109													50		50
LP-50													90		90
LP-70													37		37
Madhumoti-4								105							105
Mahico-1								67							67
Meghna								15							15
Micro								200							200
Mitali				2											2
Mitali-4						278		75							353
Moharaj								20							20
Moina		15	115	285		315	7	309	70		100		140		1356
Mollica						145									145
Nafco									90						90
Nobin						65									65
Other			203												203
Partex			59												59
Petrokom					10										10
Pioneer Agro-14													90		90
Rajkumar								395							395
Rajlakhi									5.2						5.2
Rupali	29					544									573
Sakka				187				114					105	25	431
Sampad				50				40					225		315
Sangkor											200				200
Sathi		7				262		50	200				1984		2503
Shakti				700							410				1110
Shakti-2									158.3				220		378.3
Shera						110							30		140
Sinjenta				908									28		936
Sinjenta-1201					5						300		70		375
Sinjenta-1204													35		35
Sinjenta-1205						280		115					440		835
Sonar Bangla	5												160		165
Super Agro-12									135.3						135.3
Super hybrid				25											25
Swarna					5										5
ACI-1	33		400			486		1836			150		530		3435
ACI-2			490			1179		285			140		1324		3418
Agro-12								119							119
Arize-7006									68						68
Dhani Gold		310			10	48		690	405		190		1152		2805
Hira-10						450			60						510
Pioneer				145	5								280		430
Sinjenta-1203						442		226	157		385		70		1280
SL8H	13		265	1017	56	130		1605	110				710	5	3911
Tej	10	20		614							1137		230		2011
Tej Gold					17	870		726	5				423		2041
Tia		13	310	1586		268					1340		521	25	4063
All Indian Varieties		**1597**		**100**		**423**		**10441**			**21754**				**34315**
Kajal Lata								10							10
Miniket		335						1850							2185
Ratna								40							40
Sampa Katari						421									421
Subal Lata								2745							2745
Swarna Musuri				100											100
Guti Swarna								5241							5241
Zira sail		1262				2		555			21754				23573
Other MVs Total	**46090**	**1403**	**5875**	**3487**	**30**	**416**	**53**	**27559.5**	**2809**	**70**	**21798**	**160**	**360**	**2538**	**112648.5**
Abdul Hye	7649														7649
BAU-63	8357														8357
Bhozan	4632								812						5444
Bitlab										50					50
Botle IRRI	480														480
Bowal IRRI	540														540
BRAC-576											2250				2250
Budungsa IRRI												27			27
China IRRI	3247														3247

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Debdas														250	250
Deo IRRI				1209											1209
Faijar										10					10
Ganatara								1180							1180
Goda	2														2
Golden											45				45
Good dhan			125												125
Gota IRRI	20464														20464
GS-1								487	10						497
IR-50				1055				215						50	1320
IR-76											1243				1243
ITC								680	34						714
Jamaibabu									1918						1918
Jota Pari						65									65
Khatobabu								24544							24544
Kudrat													360		360
Mala								128.5							128.5
Nayanmoni								320							320
Nerika meutant			6									103			109
Nerika-1					30										30
Other	2	230		1055						10					1297
Pach dhan		500													500
Parash		130													130
Purbachi	25		5744	158					35			30			5992
Samsu											2600				2600
Ten														2050	2050
Tepu	682														682
Nerika	10	203		10		90	53	5						188	559
Parija		340				261					15660				16261
All Local	**13625**	**7172**	**11037**	**186**	**1518**	**50**	**10306**	**2537**	**11384**	**131**	**2140**	**15634**	**5**	**3386**	**79111**
532 No.														120	120
Agali					5										5
Aijuri														35	35
Amei												413			413
Arai														3	3
Aunamia														200	200
Aus-76					961					113					1074
Badoi									295			95			390
Baduri			155		65						165				385
Baimugur							35								35
Baktulshi								1							1
Bara Dhan												971			971
Benamuri	565														565
Beti dhan												105			105
Binnatoa			550												550
Binni												2281			2281
Boilam	157		2470												2627
Botessor	100		5	20											125
Busa				5											5
Chakma Chikan												46			46
Chebenengse												12			12
Chiknal			205									98			303
Chili dhan	1000											58			1058
Chinapro												125			125
Chingri														526	526
Choroi												322			322
Company												284			284
Croning												230			230
Dali Shaita	25														25
Darial											555				555
Doyal IRRI			940												940
Dumai														337	337
Fulbadam	436														436
Gambira							155	1							156
Gazi								126							126
Gelong												1695			1695
Gorfa				51											51
Gotnori														10	10
Gouri Shaita	210														210
Goyal			10												10
Gunda dhan												151			151
Hamida			865												865
Hasa Boala								125							125
Hashi Kalmi	3432	159	3692				30	230	335	8		57			7943
Hizli											5				5
Holdemug	8														8
Horin Raja							47								47
Hyjac										5					5
Joli														65	65
Jomira						28									28
Joshohari											10				10
Joyna	20														20
Kabarak												2221			2221
Kabirmoni							15								15
Kadomoni								102							102
Kala Aus	326								15						341
Kali Boro	604														604
Kalo Bokri		1328						144							1472
Kalo Hizli								398							398
Kalo Shaita	931				90			1229	3251						5501
Kalochina											95				95
Kalomanik		25			170		42								237

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Kamarang												525			525
Karchamuri							123		10						133
Kataktara	171	2210	50												2431
Kerangdol	1660		30												1690
Khudebaron		30													30
Kotmoni												228			228
Kumrabeta	75														75
Lacha											400				400
Lakhi IRRI			20												20
Lakhi Jata							365		30						395
Lathabogi														20	20
Madhumalti												72			72
Maisora			35												35
Manikamuri	326														326
Matichak	495			65			210								770
Merong												363			363
Moisar	156														156
Mongthong												989			989
Mota Shaita	191														191
Munsur	237														237
Mura Bazal			20	20											40
Murali														877	877
Mymensing												250			250
Naroi							1551	126	730						2407
Nathompro												300			300
Nerika												347			347
Nonsaratul							103								103
Nore shaita				25											25
Paijam			90											1052	1142
Parangi		100			180		4955	25	925						6185
Parba												357			357
PD												1233			1233
Pengri	70														70
Pirpi Shaita							550								550
Poishato														20	20
Rangi												489			489
Ratul	10							30	4785						4825
Sada Shaita							1580								1580
Saloi									4						4
Sangkabati											290				290
Sapa										5					5
Shaita							545				480			101	1126
Shatia	1155		1870		47				4						3076
Sonali Chikan												315			315
Sonali IRRI			30												30
Sonamukhi												480		20	500
Soni						22					135				157
Sori												522			522
Sree bolian									1000						1000
Surjamoni	1105														1105
Sylhet IRRI	160														160
Uttara											5				5
Zira sail		3320											5		3325
Grand Total	**203081**	**49167**	**105064.9**	**97535**	**35594**	**39725**	**25600**	**150258**	**28750**	**27797**	**155593**	**18707.05**	**62195**	**175570**	**1174637**

(Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022)

Table B. Average yield (t/ha) of different Aus rice varieties by agricultural region in Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
All HYV	**4.06**	**4.05**	**4.44**	**4.70**	**4.43**	**5.04**	**3.98**	**4.97**	**4.44**	**4.09**	**4.74**	**4.11**	**4.90**	**3.98**	**4.49**
All BINA Varieties	**4.05**	**3.99**	**3.92**	**4.29**	**4.34**	**4.89**	**4.23**	**4.29**	**4.07**	**4.02**	**4.31**	**4.49**	**3.93**	**3.62**	**4.16**
Bina dhan-10			4.27												4.27
Bina dhan-12												3.64			3.64
Bina dhan-14	3.86		4.29		4.24	3.79		4.48			4.85		3.87		4.13
Bina dhan-21		4.11		4.41		5.15	3.94	4.55		3.87	4.22		4.04	2.90	4.07
Bina dhan-22		3.79													3.79
Iratom	4.24														4.24
Bina dhan-11												4.55			4.55
Bina dhan-17									4.09			4.85			4.47
Bina dhan-19	4.08	4.13	3.78	4.26	4.35	5.32	4.22	4.28	4.07	4.10	4.28	4.63	3.93	3.99	4.19
Bina dhan-20							4.55				3.94				4.24
Bina dhan-7		3.70						3.63			4.55				3.90
All BRRI Varieties	**3.93**	**4.08**	**4.17**	**4.23**	**4.17**	**4.40**	**3.76**	**4.57**	**4.10**	**4.15**	**4.56**	**3.99**	**4.04**	**3.84**	**4.12**
BR12	3.85														3.85
BR14	3.97	4.39			3.64				4.39	4.01		3.79	4.22	3.70	3.96
BR16	4.09	4.13		4.20			3.28					4.02	4.06	4.02	3.99
BR19					4.55									3.84	4.19
BR24		3.33										3.70		3.79	3.63
BR3	3.89			4.00						3.79	4.22	3.82		3.77	3.88
BR9												3.94			3.94
BRRI dhan29		3.64											4.97		4.30
BRRI dhan36		4.24													4.24
BRRI dhan37								5.05							5.05
BRRI dhan47			4.55												4.55
BRRI dhan50								4.17			4.24				4.20
BRRI dhan58				4.36	4.87	4.63		4.66					4.26		4.62
BRRI dhan63	4.24		3.94								4.55				4.24
BRRI dhan74								4.34			4.55	4.48	4.29		4.40
BRRI dhan80											4.55				4.55
BRRI dhan81								4.21			4.02				4.12
BRRI dhan83	4.05	3.94	4.15		3.89	4.73	3.96	4.68	3.99		4.55	3.89	4.55	3.77	4.09
BRRI dhan85	4.01	4.39	4.05	4.44	4.55	4.76		4.51	4.21	4.33	4.96	4.30	4.11	4.11	4.34
BRRI dhan89	4.55							4.17							4.36
BRRI dhan98			4.55	4.04				4.33		4.80				3.99	4.42
BR1		3.79										3.42		3.93	3.77
BR2	3.74			3.81	3.37				3.93						3.70
BR20	4.17			4.17										3.17	3.83
BR21	3.94	3.96			3.03						3.92			3.73	3.77
BR26	3.93	3.83		4.17	3.86	4.59	3.75	4.26	4.06	3.88	4.27	3.80	3.65	3.81	3.96
BR27	4.00	3.48	4.03	4.25			3.70		4.12			3.64		3.86	3.96
BRRI dhan28	3.33	3.95	4.89	4.16	4.14	4.06	3.69	4.58	3.95	3.98	4.71	4.05	4.04	3.88	4.15
BRRI dhan30							3.93								3.93
BRRI dhan33	3.94		4.60	4.09	3.79							3.94	4.10	4.15	4.09
BRRI dhan41										3.99					3.99
BRRI dhan42	3.54	4.60	4.10	4.27		4.02	3.79				2.66	3.95	3.62	3.57	3.81
BRRI dhan43	3.71		3.99	4.15	3.64	3.98	3.68	4.85		4.00		3.89	3.58	3.69	3.86
BRRI dhan44												4.03			4.03
BRRI dhan46												4.85	4.12		4.48
BRRI dhan48	4.10	4.22	4.16	4.55	4.43	4.11	3.86	4.75	4.18	4.12	4.96	3.71	4.39	4.15	4.29
BRRI dhan55	3.79	4.08	4.06	4.43	4.21	4.55	3.71	4.71	4.11	4.33	4.63	4.24	3.84	3.88	4.13
BRRI dhan56	4.24										4.92		4.55		4.57
BRRI dhan62								4.85							4.85
BRRI dhan65	3.87	4.14	4.39	4.04	3.83		3.69	4.85			4.58	3.98	3.74	3.53	3.97
BRRI dhan75											4.09				4.09
BRRI dhan82	4.13	4.31	4.01	4.28	4.45	4.85	3.82	4.69	4.13	4.27	4.99	4.31	4.14	4.19	4.33
All Hybrids	**5.48**	**4.63**	**5.48**	**5.54**	**5.55**	**5.47**	**5.08**	**5.64**	**5.04**		**5.61**	**5.45**	**5.60**	**5.51**	**5.48**
BRRI hybrid-2							4.85								4.85
BRRI hybrid-4							5.23								5.23
BRRI hybrid-7	7.18	4.55			5.29		4.81		5.61					5.68	5.44
ACI shera			5.85	5.77								5.45	5.12		5.55
ACI-5													6.21		6.21
ACI-8								6.14							6.14
Aftab	4.85		5.61	5.45		5.50		6.22	4.95		5.76		6.15		5.56
Agmoni			5.68						4.53						5.11
Agro-14								5.15							5.15
Agro-4				5.42											5.42
Arize				5.66				5.67					6.10		5.75
AZ								4.98							4.98
Babylon-2				5.60		5.53		4.85					5.31		5.32
Balaka						5.45									5.45
Balia				5.76				5.74							5.75
Balia-2													5.73		5.73
Bizli				5.65											5.65
BRAC-777				5.68											5.68
Camist						5.00									5.00
Chamak				5.75		5.69							5.32		5.52
Durbar			5.61												5.61
Gold			5.29	5.67			5.35								5.40
Hira		4.60	5.32	5.40				5.29	4.93				4.69	5.56	5.13
Hira-1									5.15				5.30		5.23
Hira-2	6.06				5.72	5.77					5.35		5.85		5.73
Hira-4											5.30				5.30
Hira-5	4.94					5.75					5.30		5.81		5.52
Hira-6						5.45			5.30		5.53		5.58		5.47
Ispahani			5.68	5.68		3.67		5.80					5.70		5.48
Ispahani-2						5.58		5.00					5.61		5.44
Ispahani-7													4.85		4.85
Jagaron						5.51			5.00				5.79		5.52
Janakraj						5.53							5.66		5.63
Jhalak								5.68							5.68
KBP					5.66										5.66
Krishan								5.38							5.38
Krishibid		4.35													4.35
Lakpoti				5.22											5.22
Lal Tia								5.49							5.49
Lalteer						5.61		5.82					6.03		5.82

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
LP-106													5.91		5.91
LP-108					5.45										5.45
LP-109													5.88		5.88
LP-50													6.03		6.03
LP-70													4.75		4.75
Madhumoti-4								5.66							5.66
Mahico-1								5.55							5.55
Meghna								5.56							5.56
Micro								6.21							6.21
Mitali				5.30											5.30
Mitali-4						5.76		5.68							5.72
Moharaj								4.70							4.70
Moina		4.55	5.10	5.47		5.35	5.41	5.68	5.15		5.61		5.57		5.34
Mollica						5.76									5.76
Nafco									5.45						5.45
Nobin						5.76									5.76
Other			5.75												5.75
Partex			5.52												5.52
Petrokom					5.61										5.61
Pioneer Agro-14													5.61		5.61
Rajkumar								5.52							5.52
Rajlakhi									4.84						4.84
Rupali	4.55					5.09									4.91
Sakka				5.72				5.75					4.79	5.58	5.51
Sampad				5.70				5.45					5.15		5.43
Sangkor											5.76				5.76
Sathi		5.41				5.66		5.76	5.30				5.50		5.53
Shakti				5.73							5.84				5.78
Shakti-2									4.97				6.09		5.34
Shera						5.45							5.15		5.30
Sinjenta				5.48									5.19		5.34
Sinjenta-1201					5.76						5.83		5.54		5.71
Sinjenta-1204													5.54		5.54
Sinjenta-1205						5.61		4.62					5.63		5.29
Sonar Bangla	6.06												6.00		6.03
Super Agro-12									5.01						5.01
Super hybrid				5.33											5.33
ACI-1	5.80		5.75			5.31		6.07			5.68		5.75		5.73
ACI-2			5.32			5.57		5.25			5.76		5.68		5.56
Agro-12								5.63							5.63
Arize-7006									5.10						5.10
Dhani Gold		4.55			5.30	5.25		6.28	4.71		5.76		5.63		5.55
Hira-10						5.79			4.55						5.17
Pioneer				5.47	5.15								5.18		5.32
Sinjenta-1203						5.77		5.51	4.90		5.75		5.45		5.46
SL8H	4.55		5.15	5.38	5.79	5.30		5.94	4.77				5.73	5.15	5.46
Tej	5.00	4.55		5.73							5.60		6.03		5.42
Tej Gold					5.17	5.75		5.72	5.15				5.34		5.50
Tia		4.55	5.83	5.29		5.44					5.54		5.63	5.58	5.43
All Indian Varieties		3.77		4.11		4.13		4.39			4.31				4.22
Kajal Lata								4.09							4.09
Miniket		3.98						4.13							4.05
Ratna								4.70							4.70
Sampa Katari						4.47									4.47
Subal Lata								4.43							4.43
Swarna Musuri				4.11											4.11
Guti Swarna								4.67							4.67
Zira sail		3.57				3.79		4.24			4.31				4.05
Other MVs Total	3.84	3.37	4.07	3.83	4.70	4.36	3.84	4.49	3.54	3.74	4.24	4.33	3.86	4.37	4.00
Abdul Hye	3.97														3.97
BAU-63	4.07														4.07
Bhozan	3.70								2.92						3.39
Bitlab										3.94					3.94
Botle IRRI	3.33														3.33
Bowal IRRI	3.48														3.48
BRAC-576											4.85				4.85
Budungsa IRRI												4.26			4.26
China IRRI	3.79														3.79
Debdas														6.82	6.82
Deo IRRI				3.82											3.82
Faijar										3.64					3.64
Ganatara								4.35							4.35
Goda	3.03														3.03
Golden											4.24				4.24
Good dhan			4.19												4.19
Gota IRRI	4.06														4.06
GS-1								4.24	3.48						3.99
IR-50				3.83				4.85						3.94	4.11
IR-76											4.17				4.17
ITC								4.55	3.74						4.14
Jamaibabu									4.30						4.30
Jota Pari						4.66									4.66
Khatobabu								4.83							4.83
Kudrat													3.86		3.86
Mala								4.20							4.20
Nayanmoni								4.89							4.89
Nerika meutant			4.04									4.12			4.08
Nerika-1					4.70										4.70
Other	4.55	3.44		3.81						3.64					3.85
Pach dhan		3.56													3.56
Parash		3.86													3.86
Purbachi	3.94		4.03	3.94					3.85			4.51			4.11
Samsu											4.39				4.39
Ten														3.94	3.94
Tepu	3.66														3.66
Popular Other MVS	4.09	2.95		3.79		4.21	3.84	3.94			3.92			3.84	3.74
Nerika	4.09	2.60		3.79		4.18	3.84	3.94						3.84	3.67
Parija		3.64				4.24					3.92				3.93
All Local Total	**2.13**	**2.24**	**2.12**	**1.94**	**2.22**	**2.72**	**2.00**	**1.89**	**1.95**	**2.23**	**2.48**	**2.17**	**3.03**	**2.11**	**2.13**

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
532 No.														2.22	2.22
Agali					2.12										2.12
Aijuri														1.90	1.90
Amei												1.91			1.91
Arai														2.02	2.02
Aunamia														2.05	2.05
Aus-76					3.11					2.23					2.52
Badoi									2.12			2.07			2.10
Baduri			2.08		2.75						2.27				2.30
Baimugur							1.52								1.52
Baktulshi								1.52							1.52
Bara Dhan												1.93			1.93
Benamuri	1.88														1.88
Beti dhan												1.94			1.94
Binnatoa			2.20												2.20
Binni												2.10			2.10
Boilam	1.90		2.12												2.07
Botessor	1.88		1.82	1.74											1.81
Busa				2.12											2.12
Chakma Chikan												2.35			2.35
Chebenengse												2.12			2.12
Chiknal			2.06									2.09			2.07
Chili dhan	2.32											2.42			2.37
Chinapro												2.92			2.92
Chingri														3.07	3.07
Choroi												2.04			2.04
Company												1.87			1.87
Croning												2.12			2.12
Dali Shaita	2.61														2.61
Darial											2.47				2.47
Doyal IRRI			1.97												1.97
Dumai														1.92	1.92
Fulbadam	2.02														2.02
Gambira							1.85	1.52							1.74
Gazi								2.07							2.07
Gelong												2.22			2.22
Gorfa				2.32											2.32
Gotnori														1.97	1.97
Gouri Shaita	1.64														1.64
Goyal			2.12												2.12
Gunda dhan												1.97			1.97
Hamida			2.12												2.12
Hasa Boala								1.82							1.82
Hashi Kalmi	2.45	1.99	2.20				1.67	1.90	1.71	2.25		2.02			2.09
Hizli											2.42				2.42
Holdemug	2.27														2.27
Horin Raja							2.04								2.04
Hyjac										2.42					2.42
Joli														1.93	1.93
Jomira						2.76									2.76
Joshohari											3.03				3.03
Joyna	2.20														2.20
Kabarak												2.15			2.15
Kabirmoni							1.82								1.82
Kadomoni								1.99							1.99
Kala Aus	2.36								2.12						2.28
Kali Boro	2.16														2.16
Kalo Bokri		2.22						1.72							1.97
Kalo Hizli								1.88							1.88
Kalo Shaita	2.11				1.82			2.13	2.49						2.13
Kalochina											2.04				2.04
Kalomanik		1.89			2.12		1.66								1.95
Kamarang												2.17			2.17
Karchamuri							2.14		1.97						2.08
Kataktara	2.04	2.15	2.18												2.10
Kerangdol	2.20		1.62												1.91
Khudebaron		2.27													2.27
Kotmoni												2.61			2.61
Kumrabeta	2.20														2.20
Lacha											1.85				1.85
Lakhi IRRI			2.80												2.80
Lakhi Jata							2.01		1.82						1.95
Lathabogi														1.89	1.89
Madhumalti												2.10			2.10
Maisora			2.01												2.01
Manikamuri	2.12														2.12
Matichak	2.08			1.84			2.12								2.03
Merong												1.59			1.59
Moisar	1.79														1.79
Mongthong												1.99			1.99
Mota Shaita	2.27														2.27
Munsur	2.11														2.11
Mura Bazal			2.27	1.82											2.05
Murali														1.80	1.80
Mymensing												2.65			2.65
Naroi							2.17	1.66	1.91						2.05
Nathompro												2.27			2.27
Nerika												2.45			2.45
Nonsaratul							1.97								1.97
Nore shaita				1.82											1.82
Paijam			1.87											2.20	2.03
Parangi		2.27			1.82		1.91	1.82	1.89						1.93
Parba												2.50			2.50
PD												2.27			2.27
Pengri	2.49														2.49
Pirpi Shaita							2.20								2.20
Poishato														1.82	1.82
Rangi												1.61			1.61
Ratul	1.97							2.42	1.93						2.04

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Sada Shaita							2.30								2.30
Saloi									1.89						1.89
Sangkabati											2.27				2.27
Sapa										1.97					1.97
Shaita							2.10				2.50			1.91	2.16
Shatia	1.94		2.08		2.12				1.89						2.04
Sonali Chikan												2.27			2.27
Sonali IRRI			2.83												2.83
Sonamukhi												2.20		1.89	2.10
Soni						2.69					2.87				2.78
Sori												2.12			2.12
Sree bolian									1.80						1.80
Surjamoni	2.01														2.01
Sylhet IRRI	2.25														2.25
Uttara											3.03				3.03
Zira sail		2.91											3.03		2.97
Grand Total	3.59	3.87	3.87	4.49	4.16	4.97	3.30	4.68	3.94	3.81	4.46	3.11	4.89	3.58	4.07

(Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022)

Table C. Adoption (ha) of different Aman rice varieties by agricultural regions of Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
All HYV	**408521**	**369430**	**499290**	**178154.5**	**253034.8**	**492459**	**140380**	**450654**	**242021**	**507870**	**349750**	**46110.3**	**589637**	**458579**	**4985891**
All BINA Varieties	**5478.4**	**29947**	**4516**	**6753**	**9547.4**	**4298**	**26750**	**44043**	**11593**	**17273**	**17835**	**2328.88**	**18561**	**18392**	**217315.7**
Bina dhan-1	506.25														506.25
Bina dhan-10									76				200		276
Bina dhan-12			28									700			728
Bina dhan-13	30		2	47											79
Bina dhan-14	48														48
Bina dhan-15			15	20											35
Bina dhan-21		5					15						25		45
Bina dhan-22	8.7	168	21	235		2	190	274	362		113		51	10	1434.7
Bina dhan-23													90		90
Bina dhan-9			1												1
Bina sail										175			2		177
Iratom-24														5	5
Bina dhan-11	549.6	134	594	424	2510.2	35	1630	373	692	3440	85	549.62	4197	2261	17474.42
Bina dhan-16	687.25		117	190	141	80	95	895	45	75	45	188	308	275	3141.25
Bina dhan-17	1187	9823	1054	1159	1364.2	1939	9272	13621	2555	1080	4650	621.67	5696	4786	58807.87
Bina dhan-19	247.8	521					10		25		2	41	5	20	871.8
Bina dhan-20	738.05	804	165	232	271	105	174	351	660	445	101	208.59	224	134	4612.64
Bina dhan-7	1475.75	18492	2519	4446	5261	2137	15364	28529	7178	12058	12839	20	7763	10901	128982.8
All BRRI Varieties	**363789.6**	**156466**	**376269**	**164446.5**	**201785.9**	**167164**	**100171**	**211560**	**193068**	**362594**	**153204**	**33161.52**	**218704**	**423124**	**3125508**
BR10	260		4618	1270				943	30870	60		476		5331	43828
BR12									217						217
BR14	575				90										665
BR25	87			497	555		10					942.5			2091.5
BR3	380								5			20			405
BR5									1651						1651
BRRI dhan29		60			267						1175			400	1902
BRRI dhan31	139														139
BRRI dhan36		1829													1829
BRRI dhan37		5													5
BRRI dhan50					1						28				29
BRRI dhan53	70											22			92
BRRI dhan54	353		1						45			17			416
BRRI dhan59														50	50
BRRI dhan63	1144					40									1184
BRRI dhan66		826	558			52	40	90	50		6		64		1686
BRRI dhan67									1324						1324
BRRI dhan70	20	505	282		103	121		340	115		5	81	207		1779
BRRI dhan72	3286	499	3583	760	1720	2422	1961	2492	1130	2580	995	285	3863	2040	27616
BRRI dhan73	1071.25		743	411	48		215	216	1020		20	50.47	20		3814.72
BRRI dhan74		500			15	20		25		140	10	96			806
BRRI dhan76	15045	162	1498			119	162	20	2451		13		197	599	20266
BRRI dhan77	6885		195			14	95	10	225	76			91		7591
BRRI dhan78	1138.85		642			26		15	2031						3852.85
BRRI dhan79	15	97	207		14		7	10		40			939	478	1807
BRRI dhan80		568	2221	681	977	281	435	5307	3643	1222	690	74.7	3037	155	19291.7
BRRI dhan81					13						2				15
BRRI dhan85	1832.25				110		120								2062.25
BRRI dhan88			10												10
BRRI dhan90		200	4		45	48	31	345	101	68	38		20	108	1008
BRRI dhan91		92	1	5		5	13		15	23			20		174
BRRI dhan92		15													15
BRRI dhan93			3	10	37.5034	175	5		16	86	36		161	5	534.5034
BRRI dhan94		16	2	30	114.2	1		5	25		18		112	18	341.2
BRRI dhan95		10	19	23.5	5.2	130			25	31	48		190	16	497.7
BR11	65850	8053	21483	2057.5	4043	1029	2514	1605	8600	12410	319	7519	56735	40771	232988.5
BR2													35		35
BR20													15		15
BR22	32945	7915	46646	62383	20875		127	794	10519	17187		738	356	46491	246976
BR23	75808	406	33639	10316	555		201	753	34525	4104	30	7	2742	11160	174246
BRRI dhan28		225		725	193		156		2440	1170	5		2167	260	7341
BRRI dhan30	433		695		385			1120	17289		125	30		120	20197
BRRI dhan32	1249	782	8654	11211	4636		105		16	27433	90	451	245	13751	68623
BRRI dhan33	197	4257	8433	110	245		17705	10649	1973	325	2592	2443	4306	420	53655
BRRI dhan34	857	19097	55	2528.5	2181	92723	429	1127	628	25688	24968	98	9098	4582	184059.5
BRRI dhan39	128	10389	8336	3147	877		28931	19822	6105	4007	5748	2185	3504	5869	99048
BRRI dhan40	7395	20	18521	55	51		210		60	170		1019	549	1155	29205

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BRRI dhan41	8898	397	10251	800	337		180		1076	1845	10	762	908	3564	29028
BRRI dhan44	13582		2503	221			175					185	74	815	17555
BRRI dhan46	993		6713	11429	450	131	105			997		545		9013	30376
BRRI dhan48			120					245							365
BRRI dhan49	14520	62460	90382	40659	134466	16575	14747	47225	31502	196450	27058	8943.5	24422	116775	826184.5
BRRI dhan51	7137	12343	19029	1126	9643	37550	4480	36146	2302	22078	68961	1099	23249	122373	367516
BRRI dhan52	97743	8396	65774		6063	8722	5926	5508	12223	27219	2115	1593	56801	22608	320691
BRRI dhan55		42			30										72
BRRI dhan56	269	1424			240	480	821	431	22	241	607	534.5	3895	500	9464.5
BRRI dhan57	672	1415	216		12	575	755	1031	8	158	20	60	368		5290
BRRI dhan62	467	1190		210	187	1168	753	3689	610	290	193	5	921	490	10173
BRRI dhan65												80			80
BRRI dhan71	1311	1595	2901	245	1698	205	654	9269	1388	9375	3434	1760.09	5215	2104	41154.09
BRRI dhan75	468.25	5467	7697	2778	2397	2462	109855	25297	7704	1992	5990	992.66	6249	5070	85548.91
BRRI dhan82						7					5				12
BRRI dhan87	566	5209	9634	10758	8107	2083	7118	37031	9119	5129	7850	47.1	7929	6033	116613.1
All Hybrids	**697**	**19667**	**11262**	**3773**	**13226.5**	**44310**	**10892**	**39457**	**18081**	**65607**	**3891**	**933**	**59468**	**436**	**291700.5**
BRRI hybrid-2							97								97
BRRI hybrid-3														1	1
BRRI hybrid-4		27	6	14	70.5		178.5	50	31	223			120	30	750
BRRI hybrid-6	60		8	19.5	25		142	45	288	75	5		210	57	934.5
ACI		450	662	60			15	280		1001	20	135			2623
ACI-3													190		190
ACI-4													193		193
ACI-6						40									40
Aftab						682							30		712
Agmoni						90			203				200		493
Agrani-7									25				10		35
Agro- dhan									4973						4973
Agro dhan-14			255							130					385
Agro-6										275					275
Agroban					401										401
Agroji													30		30
Aloran	85		120			202			285				640		1332
Altab LP-70						750									750
Arize										390			2860		3250
Arize AZ-800								80							80
Arize Gold			250				75								325
Arize Tej						200		485	5						690
Arize Tej Gold						195									195
Arize-1206													358		358
Arize-Z													50		50
AZ-7005						1634									1634
AZ-7007									75						75
AZ-7206				300											300
Babylon						485			25						510
Babylon-2							5		43				370		418
BADC					10										10
BADC-1								85							85
BADC-2		75													75
Badsha								35							35
Balia					215	85							1072		1372
Balia-2						175		70							245
Bayar		350					200								550
Bayar-6007											20				20
Bengal										15					15
Brac-1			449			500							100		1049
Brac-10				30			5	20	258.8						313.8
Chamak						105		15					180		300
Chikaner badsha					70										70
Dhani						74									74
Doyal								40							40
Durbar						120							218		338
Falan												118			118
Frontline-1203														5	5
Getko						80									80
Gold	60						26						337		423
Golden										3					3
Golden-1						140	465								605
Hira	137	560	718	15	110				1103			205	270		3118
Hira-16							161			613			294		1068
Hira-2		80				90			102				4448		4720
Hira-5													1465		1465
Hira-6						120					8			28	156
Hybrid dhan-10			30												30
Ispahani					61	135		120					1167		1483
Ispahani-1													356		356
Ispahani-2						1162		376					1240		2778
Ispahani-6								60							60
Ispahani-7						400									400
Jagaron						70							355		425
Jamuna										2			295		297
Janakraj		35	20			590				74			605		1324
Jhalak								58							58
KBP-1									1						1

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Krishak-2													90		90
Krishan								50							50
Krishibid seeds		150				490			267				75		982
Lal teer								52					550		602
Madhumoti								65							65
Madhumoti-5							23								23
Mahi Gold										582					582
Mahico		20		15									120		155
Mahico-1							180	520							700
Mitali				16					10						26
MJ-0032								191							191
Moharaj		5								11					16
Moina			80			10	15						850		955
Mongal		50			10										60
Monihar													95		95
MS-1									163				310		473
Mukti													35		35
Mukti-1			30			453			950	471			295		2199
Mukti-2										302					302
Nafco-108						15							429		444
National							80								80
National Agri care													300		300
Nilsagor								35							35
Nobin						820		101		14			100		1035
Other		100	20				40								160
Pacific													5		5
Patex		10						145					5		160
Patex-1													522		522
Petrokom					15										15
Pioneer-12					337										337
Pioneer-14													180		180
Power										125					125
Rajkumar			30										140		170
Rupali		146							47				120		313
Rupshi Bangla													584		584
Rupshi-4						30									30
Sakka				30										10	40
Sampad		140	65				2	20		136		85	285		733
Sathi	50	154	50			371			24				1490		2139
Shakti		170	65										140		375
Shakti-2						225	107						805		1137
Shera				260	95					250				150	755
Sinjenta		970			780					129					1879
Sinjenta-1201							62	820					95		977
Sinjenta-1202					2		170	380							552
Sinjenta-1205						10							100		110
Sinjenta-1206										430					430
Sinjenta-1210							310								310
SL Super													369		369
Sonar Bangla	2	10				2300					8		1118		3438
Subarna													245		245
Sura													15		15
Surovi		60													60
Suvra			50												50
Tinpata				25		170							370		565
Uni-207								900							900
Win-270											50				50
Win-868						30									30
Winall Hi Tech Seed			2												2
ACI-1	8					1820							2688		4516
ACI-2	40					5061							2499		7600
Agro-12	180	232	11	128		420	1810	2537		1866			164		7348
Arize-7006	75	6071	2968	1530.25	4845	3394	2504.8	14265	3100	20880	642	19	3975	58	64327.05
Dhani Gold		7958	4698	726	5225	17983	3454	16447	4790	31907	2085	285	11909	40	107507
Hira-10						770			380				3777	52	4979
Pioneer		130	271	75		393			307	4112		80	1390		6758
Sinjenta-1203				140	11	105	351	727		475	310		461		2580
SL8H		25	254	14.25	85		400.3	350					505		1633.55
Tej		734		90	785	182	3.4				743		1225		3762.4
Tej Gold		855	85	240	74	91		33	625.2	1009			720	5	3737.2
Tia		100	65	45		1043	10			107		6	2655		4031
All Indian Varieties	**24085**	**136022**	**48128**	**2627**	**8965**	**267326**	**2070**	**139714**	**9847**	**24790**	**169900**	**1259**	**289369**	**15007**	**1139109**
Kajal								1555							1555
Madabi										6030					6030
Madabilata					730										730
Miniket		467				14		410							891
Molla Katari						70									70
Potalpairi		100													100
Ratna									20						20
Sampa Katari						2248					8619				10867
Suballata								3470							3470
Lal Swarna								7015							7015
Mamun Swarna		11189				3625							14893		29707
Nepali Swarna						4300							648		4948
Sada Swarna								2125							2125
Sumon Swarna						28125									28125

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Swarna Musuri			47398	1100		386				6335		1259			56478
Swarna-5						31071							26046		57117
Guti Swarna	24085	92345		1527	2215	190638	2070	124829	9827		154388		234297	6885	843106
Ronjit		30911	730		6020	6849		310		5565	2763		13485	8122	74755
Zira sail		1010									4130				5140
Other MVs Total	**14471**	**27328**	**59115**	**555**	**19510**	**9361**	**497**	**15880**	**9432**	**37606**	**4920**	**8427.9**	**3535**	**1620**	**212257.9**
Abdu Guti											240				240
Abdul Hye	700														700
Asami														1320	1320
Basmoti						1									1
Bhojan	2435								1176						3611
Bogura sampa						395									395
Borna						540				500			520		1560
Chaon		515													515
China													760		760
Golden Atab											80				80
Gota IRRI	2491		1210												3701
Grson						230									230
GS-1								1088							1088
Habu dhan								3560							3560
Hutra											5				5
IRRI sail												240			240
IT									1958						1958
Jamaibabu									6298				110		6408
Jotapari						515									515
Kataribhog		19916													19916
Khato								6930							6930
Khato-10											1600				1600
Komal						85									85
Kotra						2255									2255
Nania						152									152
Naoga								302							302
Other		109	2				497			365			630		1603
Pathargata						5									5
Porasmoni		500													500
Protik								3500							3500
Purnima						645									645
Raich		2953													2953
Ranjana						2295							600		2895
Rupsha								500							500
Sakkapanja												920			920
Satabdi						165									165
Siattor						330									330
Sonali pajam												2063			2063
Sonamukhi						1528									1528
Sylheti pajam												1422			1422
Tepu	1291														1291
Hori dhan	7546		16387		1305					14721	50	1827.9	285		42121.9
Pajam	8	3335	41516	555	18205					22020	2945	1955	50	300	90889
Parija						220							580		800
All LVs Total	**301094**	**23817**	**73075**	**14069**	**29839**	**2971**	**18990**	**3320**	**59093**	**81087**	**30847**	**2138**	**12530**	**46930**	**678364**
Jul							200								200
Absaya					3490					920					4410
Agni	5														5
Agrani sail			500												500
Aguni/Agni			650	75								29			754
Akhani sail							230							2048	2278
Alebro			1185												1185
Aloi					2160								740		2900
Argoja	1673														1673
Arman sarder	2553								181						2734
Arparina							220			487					707
Ashfal									143						143
Ayna sail														300	300
Azdaha							40								40
Babuibhog													73		73
Badai	190						415								605
Badal														205	205
Badshabhog		20				40	70	461	115			144	70		920
Baismoti										533					533
Balam			734		434		594		632	983				1040	4417
Baonkhir	260														260
Basa												31			31
Basful Badam	2284								1275						3559
Bashiraj		40					50								90
Basmoti													10		10
Baspair	15								915						930
Bazai							30								30
Bazal			470												470
Begunbichi		92								30			81		203
Benama										112					112
Benapol									1149						1149
Bennagour	50														50
Beti														250	250
Beti balam									1070						1070

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Beti chikan	1875		95												1970
Beto													35		35
Bhog Dhan													3		3
Bhozan	617														617
Bilualaha							80								80
Bina sail					664		145						623	1080	2512
Binnaful											3733				3733
Binni	117		4265	159	235					144		872	240		6032
Biroi					389					2301					2690
Biroin														5567	5567
Birpala								322							322
Boari	1617														1617
Bodiraj										629					629
Bor Hafzi										8229				100	8329
Bora digha							30								30
Bosi		50													50
Bozramuri									145						145
Brindhi	506														506
Bushihara	7466		750	18			417								8651
Bute salute									195						195
Butia Pajam										1070					1070
Chanmoni										265		41		400	706
Chap sail	285				160				269						714
Chapail									1030						1030
Chapalni										2836					2836
Chaplas	730													1720	2450
Chata bazal				850											850
Chengermuri														1910	1910
Chengul											35				35
Chikan dhan												5			5
Chinapro												19			19
Chini		636					78		276		25080				26070
Chini sail										13861					13861
Chinigura	1671		396	30	904	120	5		210			175	138	614	4263
Chinikanai									1238						1238
Chinikatari						3									3
Chinisagor										1475					1475
Chollis zira						124									124
Chorboshor	1675														1675
Dalamota			1640												1640
Dalkachu	755									515	65				1335
Dekibhog						20									20
Depa									4						4
Depo					21			140	265						426
Digha								150	600						750
Dinga sail	1553														1553
Dud bazal				380											380
Dudmona	6748						410								7158
Dudmoni							237								237
Dudsor	15266								1518		290				17074
Dulabhog													195		195
Ekar Chaul										220					220
Fariamota	1490														1490
Fulbadam	32														32
Fulgazi										245					245
Gabrail	50														50
Gacha			270	402			770								1442
Gainja				267	4044									1180	5491
Ganda Kosturi	60														60
Gandi sail					952										952
Garia													50		50
Gasani	56														56
Geromoti									80						80
Gigos			4255	578					302			135			5270
Gikosh	665														665
Goalgosh								40							40
Gocha								315	1190						1505
Golapi					160					1322					1482
Golok Khoiya	343														343
Gomti				50											50
Gonoveri					520										520
Gonshi									704						704
Gothak														165	165
Green sail			80												80
Guti IRRI														45	45
Guti Swarna	11665			158	13										11836
Haloi										6966					6966
Hargoja	278														278
Hashful					30										30
Hasim														875	875
Hawai				247											247
Hobigonj		15													15
Hoglapata	125								649						774
Holdi	1135												655		1790
Horibhog									35						35
Horkot									90						90
IRRI boz									5						5
Jabra							4		893						897
Jafor IRRI							27								27
Jamai													3		3
Jamri mota	449														449
Jinga sail							63								63

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Jogdala											10				10
Joldepa													819		819
Jota						281									281
Jotabalam									2188						2188
Jotapari													10		10
Joyna	48								965						1013
Jumur								15	15						30
Jur									15						15
Kachamou	2538														2538
Kainol										398					398
Kaisabinni					10					33					43
Kajal sail	8790		7723												16513
Kala	220														220
Kalakhoi	632														632
Kalamadari							20								20
Kalamanik	1356												260		1616
Kalamota	9339		3640												12979
Kalaraja					10										10
Kaligo			720												720
Kalo zira	5995	280	2206	1873	2830	448	216	572	665	3321	148	608	1388	1512	22062
Kamak kamani					270										270
Kamalamota	224														224
Karamcha											40				40
Kareng	1412														1412
Kartik balam	445								45						490
Kartik sail	1418		6905	34	65		355		435					75	9287
Kasra									1565						1565
Kataribhog			122	236		987					1431		81		2857
Keymou	1706														1706
Kharamo	2475														2475
Khasa														120	120
Khejursori									90						90
Khek sail									65						65
Kheya	823														823
Khiloi					1300										1300
Khirkone								441	140						581
Khirsabhog													347		347
Khirsapat					100										100
Khondola			60												60
Khormonor	333														333
Khoto bada											15				15
Khurapoti					1781										1781
Koijuri									302						302
Korchamuri							3								3
Kuiamoni			270												270
Kumra boilam			305												305
Kumragour	1504								464						1968
Kumri										3078					3078
Kuti Agrani	6461														6461
Kuti Angti							1253								1253
Kuti Chikan				137											137
Kuti sail	1955														1955
Laita										235					235
Lakhi digha	0.22						259								259.22
Lakhi Kajal			380					17							397
Lal					115										115
Lal Balam									195						195
Lal Chikan	7121						607								7728
Lal Gora													120		120
Lal Kartik	538														538
Lal mota	24980								8764						33744
Lal Paika							70								70
Lal pajam			180												180
Lal Zira			120												120
Lamba Bhozan							370								370
Lati sail					30										30
Lator mota	1720														1720
Lebu sail							245								245
Leha Gorcha							750								750
Lohadong					5					22					27
Lohati					12										12
Lokma	105								580						685
Loti sail		6	1510		280		699			576				2382	5453
Lotor			170												170
Madavilata										565					565
Madhu Sail					235		50								285
Madhumalti	579		453												1032
Malanchi										50					50
Malsira													1381		1381
Malti sail					575					90				2890	3555
Master										40					40
Matichak	700														700
Megraj														275	275
Mesi sail					147										147
Modonga														560	560
Mogaibeti	170														170
Moinamoti	500						647		639						1786
Moisamuri			2870												2870
Mon sail														3661	3661
Monohor								580	415						995
Montesor	5658								5892						11550
Morish sail									1674						1674
Mota Chikan							494								494

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Mota Malti										520					520
Motha Mota	25049														25049
Motihari			72												72
Moulta	11396														11396
Mukut													480		480
Mura Bazal			6315	2995											9310
Muri Sail				55											55
Nagpachi			910												910
Naizer sail	120	503	135	1454	4939		1473	90	264	1828			2181	2191	15178
Nakuchi Mota	5735														5735
Nalkosh	245														245
Naosa										270					270
Naringa							129								129
Naspati	50														50
Nayaraj										1055			525		1580
Nonakhorsi	1834								1922						3756
Nunia						248							12		260
Other		19	10				76			1612					1717
Pajam				930			2103						147	3653	6833
Palabir	165														165
Panisai													362		362
Panja			1250												1250
Pankais	25														25
Parbat zira														210	210
Pari													4		4
Parijat										2640					2640
Pat													10		10
Patjag		460			1861										2321
Patnai									30						30
Philiphin						397									397
Pipralais			464	145											609
Pirpi sail							100								100
Potalpairi													160		160
Rahman										155					155
Rai chikan			678												678
Raja Aman				321											321
Raja sail	5766		19389				826								25981
Rajbhog					535										535
Rangamoni												37			37
Rani Salut									1820						1820
Rasulbhog													245		245
Roamodi										300					300
Ronjit				672	16					395				9435	10518
Rosmala										175					175
Sabar										40					40
Sabarmal	50														50
Sada Balam									180						180
Sada Chikan	4750						126								4876
Sada Mota	74608						619		14067						89294
Sagor	56														56
Saheb Chikan			868												868
Saila		98													98
Sailgirmi	282.78														282.78
Sakkapanja												7			7
Sakkarkhana	4612		20						125						4757
Salkani								30							30
Samna							1068								1068
Sampati							8								8
Sapahar		160								25			185		370
Satia													80		80
Satrabhog									65						65
Silkom		1					80								81
Sishumoti							1660	140	100						1900
Sita	170														170
Sona Digha							23								23
Sonamukhi					24										24
Sonar Bangla														220	220
Subarna lata									48						48
Sumaiya												35			35
Sunmoon										220					220
Swarna lata										1112					1112
Swarna Musuri	11781			1218											12999
Tak sail									94						94
Tepa		1													1
Tepu sail	395						546								941
Til			10						47						57
Tilkabor					155								374		529
Tilok					10										10
Tula sail			30												30
Tulshimala				660	348					14926				105	16039
Uknimadhu													276		276
Urichidra									40						40
Uzal													79		79
Zira badam					10					4263					4273
Zira katari						303									303
Zira sail				125				7					88	2142	2362
Grand Total	**709615**	**371811**	**572365**	**192223.5**	**282873.8**	**495430**	**159370**	**453974**	**301114**	**588957**	**380597**	**48248.3**	**602167**	**505509**	**5664255**

Table D. Average yield (t/ha) of different Aman rice varieties by agricultural region in Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
All HYV	**4.13**	**4.76**	**4.74**	**4.59**	**4.60**	**4.96**	**4.89**	**5.15**	**4.68**	**4.63**	**4.94**	**4.58**	**4.63**	**4.43**	**4.69**
All BINA Varieties	**3.96**	**4.50**	**4.30**	**4.26**	**4.37**	**4.56**	**4.54**	**5.04**	**4.34**	**4.10**	**4.79**	**4.27**	**4.26**	**4.25**	**4.39**
Bina dhan-1	3.94														3.94
Bina dhan-10									4.39				4.70		4.49
Bina dhan-12			4.23									4.18			4.20
Bina dhan-13	3.03		3.79	4.23											3.82
Bina dhan-14	3.94														3.94
Bina dhan-15			3.94	4.24											4.09
Bina dhan-21		4.24					4.85						4.09		4.39
Bina dhan-22	3.94	4.63	4.47	4.24		5.30	4.54	5.10	4.35		4.82		4.41	5.00	4.63
Bina dhan-23													3.74		3.74
Bina dhan-9			3.03												3.03
Bina sail										3.42			3.79		3.61
Iratom-24														3.94	3.94
Bina dhan-11	4.00	4.38	4.33	4.32	3.96	4.41	4.48	5.10	4.47	4.21	4.69	4.37	4.11	4.26	4.33
Bina dhan-16	4.27		4.36	4.28	4.67	4.57	4.60	5.09	4.20	4.17	4.80	4.29	4.39	4.23	4.46
Bina dhan-17	3.58	4.43	4.30	4.07	4.49	4.55	4.69	5.22	4.35	4.17	4.95	4.55	4.70	4.31	4.49
Bina dhan-19	4.09	4.59					4.02		4.39		6.06	4.07	4.02	3.99	4.35
Bina dhan-20	4.15	4.72	4.45	4.31	4.53	4.54	4.56	4.99	4.38	4.07	4.71	4.38	4.22	4.11	4.46
Bina dhan-7	3.94	4.36	4.58	4.36	4.23	4.40	4.46	4.81	4.20	4.09	4.45	3.18	4.05	4.13	4.29
All BRRI Varieties	**4.08**	**4.45**	**4.42**	**4.29**	**4.36**	**4.53**	**4.44**	**4.85**	**4.44**	**4.26**	**4.70**	**4.46**	**4.20**	**4.23**	**4.39**
BR10	4.09		4.62	3.90				4.09	4.33	3.59		4.40		4.16	4.23
BR12									3.71						3.71
BR14	4.24				3.79										4.02
BR25	3.85			4.24	4.02		4.55					4.36			4.14
BR3	3.74								3.79			3.79			3.76
BR5									5.58						5.58
BRRI dhan29		4.39			4.07						5.15			3.98	4.33
BRRI dhan31	3.89														3.89
BRRI dhan36		4.18													4.18
BRRI dhan37		4.24													4.24
BRRI dhan50					3.48						5.14				4.31
BRRI dhan53	4.39											4.48			4.44
BRRI dhan54	4.14		3.03						4.37			4.70			4.13
BRRI dhan59														4.06	4.06
BRRI dhan63	5.15					3.56									4.36
BRRI dhan66		4.44	3.79			4.55	4.39	4.55	4.76		4.85		3.96		4.38
BRRI dhan67									4.54						4.54
BRRI dhan70	3.86	4.39	4.52		4.06	4.67		4.89	4.39		4.42	4.73	4.09		4.39
BRRI dhan72	4.30	4.41	4.46	4.28	4.63	4.77	4.55	5.10	4.53	4.18	4.74	4.45	4.53	4.43	4.55
BRRI dhan73	4.22		4.49	4.36	4.36		4.70	5.03	4.43		4.85	4.87	4.09		4.50
BRRI dhan74		5.00			4.24	4.47		5.45		4.24	4.85	4.11			4.58
BRRI dhan76	4.26	4.58	4.43			4.70	4.44	4.70	4.61		5.12		4.29	4.25	4.45
BRRI dhan77	4.18		4.28			4.76	4.17	4.85	4.77	5.42			4.28		4.42
BRRI dhan78	4.38		4.41			4.67		4.55	4.63						4.46
BRRI dhan79	4.09	4.42	4.74		4.55		4.33	4.85		4.39			4.22	4.41	4.43
BRRI dhan80		4.71	4.47	4.49	4.64	4.66	4.73	5.03	4.48	4.25	4.94	4.45	4.27	4.21	4.60
BRRI dhan81					5.36						4.55				4.95
BRRI dhan85	4.19				4.33		4.73								4.29
BRRI dhan88			3.94												3.94
BRRI dhan90		4.70	3.79		4.55	4.37	4.51	4.91	4.56	4.36	4.87		4.30	4.56	4.50
BRRI dhan91		4.79	3.03	4.55		4.85	4.43		4.35	4.17			4.32		4.37
BRRI dhan92		4.85													4.85
BRRI dhan93			5.05	4.85	4.23	4.90	4.55		4.47	4.24	4.20		4.61	4.24	4.53
BRRI dhan94		4.85	4.55	4.66	4.53	5.00		5.02	4.30		4.17		4.67	4.69	4.59
BRRI dhan95		5.30	4.83	4.62	4.36	5.00			4.47	4.11	5.15		4.63	4.67	4.75
BR11	4.16	4.31	4.50	4.08	4.34	5.06	4.38	5.09	4.34	4.23	4.12	4.41	4.42	4.19	4.39
BR2													3.56		3.56
BR20													4.09		4.09
BR22	3.98	4.38	4.48	4.22	4.20		4.38	4.81	4.38	4.24		4.20	4.08	4.13	4.26
BR23	4.07	4.22	4.42	4.17	4.15		4.04	4.58	4.25	4.19	3.86	5.30	3.93	4.16	4.20
BRRI dhan28		4.55		4.38	5.57		3.41		4.97	4.09	4.85		4.09	3.94	4.48
BRRI dhan30	3.94		4.55		4.29			4.53	4.25		4.88	4.24		4.08	4.30
BRRI dhan32	3.93	4.18	4.36	4.16	4.16		4.20		3.61	4.25	4.37	4.20	3.79	4.02	4.15
BRRI dhan33	3.90	4.49	4.19	4.09	4.45		4.41	4.55	4.51	4.19	4.44	4.45	3.86	4.29	4.29
BRRI dhan34	3.75	3.59	4.20	3.99	3.59	3.39	3.50	4.01	4.23	3.88	3.52	4.44	3.55	3.88	3.76
BRRI dhan39	3.79	4.23	4.42	4.14	3.92		4.49	4.66	4.19	4.46	4.61	4.41	4.06	3.90	4.27
BRRI dhan40	3.89	4.24	4.42	4.00	4.45		4.36		5.18	4.37		4.27	4.09	4.14	4.25
BRRI dhan41	3.95	4.31	4.41	4.15	4.43		4.32		4.61	4.18	4.39	4.02	3.96	4.08	4.20
BRRI dhan44	4.04		4.77	4.32			4.77					4.80	4.09	4.02	4.29
BRRI dhan46	4.02		4.40	4.12	4.36	4.79	4.17			4.12		4.65		4.09	4.28
BRRI dhan48			3.97					4.85							4.41
BRRI dhan49	4.06	4.45	4.59	4.52	4.60	4.61	4.56	4.94	4.31	4.53	5.10	4.56	4.27	4.38	4.53
BRRI dhan51	4.19	4.47	4.59	4.37	4.34	4.73	4.62	4.93	4.44	4.40	5.47	4.44	4.23	4.13	4.51
BRRI dhan52	4.30	4.48	4.65		4.44	4.51	4.72	4.77	4.48	4.44	5.23	4.77	4.40	4.13	4.55
BRRI dhan55		4.55			5.00										4.77
BRRI dhan56	4.10	4.71			4.26	4.30	4.63	4.78	4.45	4.21	4.77	4.23	4.13	4.02	4.38
BRRI dhan57	4.24	4.27	3.82		3.67	4.34	4.61	4.59	4.36	4.38	4.55	4.70	4.10		4.27
BRRI dhan62	3.77	4.19		4.24	4.48	4.16	4.37	4.72	4.34	4.14	4.31	4.24	3.82	4.02	4.22
BRRI dhan65												4.70			4.70
BRRI dhan71	3.74	4.40	4.47	4.42	4.33	4.51	4.52	4.99	4.41	4.28	4.67	4.70	4.32	4.36	4.42
BRRI dhan75	4.34	4.71	4.50	4.47	4.48	4.79	4.50	4.99	4.59	4.30	4.98	4.45	4.48	4.31	4.57
BRRI dhan82						3.89					4.55				4.22
BRRI dhan87	4.21	4.86	4.65	4.69	4.80	4.87	4.58	5.29	4.54	4.24	5.15	4.37	4.42	4.94	4.72
All Hybrids	**5.47**	**5.75**	**6.09**	**5.71**	**5.71**	**5.61**	**6.05**	**6.03**	**5.76**	**5.64**	**6.46**	**6.25**	**5.20**	**6.00**	**5.71**
BRRI hybrid-2							5.06								5.06
BRRI hybrid-3														5.61	5.61
BRRI hybrid-4		6.12	6.06	5.95	5.73		6.05	6.52	5.77	5.45			5.19	5.96	5.82
BRRI hybrid-6	5.45		6.06	6.06	6.61		5.84	6.44	5.60	5.45	6.36		5.03	6.14	5.84

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
ACI		5.61	6.14	5.73			5.91	5.61		5.53	6.36	6.47			5.91
ACI-3													5.18		5.18
ACI-4													5.17		5.17
ACI-6						5.45									5.45
Aftab						5.23							5.42		5.35
Agmoni						5.39			7.27				5.23		5.96
Agrani-7									5.15				5.30		5.23
Agro- dhan									6.30						6.30
Agro dhan-14			6.36							5.91					6.14
Agro-6										5.70					5.70
Agroban					5.61										5.61
Agroji													5.26		5.26
Aloran	5.59		6.02			5.58			5.91				5.16		5.57
Altab LP-70						6.05									6.05
Arize										5.89			5.42		5.58
Arize AZ-800								5.45							5.45
Arize Gold			6.21				6.23								6.22
Arize Tej						5.68		5.70	5.15						5.51
Arize Tej Gold						6.02									6.02
Arize-1206													5.23		5.23
Arize-Z													5.39		5.39
AZ-7005						5.89									5.89
AZ-7007									5.92						5.92
AZ-7206				5.55											5.55
Babylon						5.45			5.41						5.43
Babylon-2							5.83		5.74				5.17		5.58
BADC					6.06										6.06
BADC-1								6.41							6.41
BADC-2		5.32													5.32
Badsha								5.15							5.15
Balia					5.88	5.45							5.20		5.44
Balia-2						5.35		5.30							5.33
Bayar		6.09					5.53								5.90
Bayar-6007											6.82				6.82
Bengal										6.26					6.26
Brac-1			6.11			5.15							5.91		5.72
Brac-10				5.65			5.76	5.45	6.59						5.86
Chamak						5.38		6.36					5.15		5.63
Chikaner badsha					5.91										5.91
Dhani						6.06									6.06
Doyal								6.52							6.52
Durbar						5.45							5.15		5.30
Falan												6.06			6.06
Frontline-1203														6.06	6.06
Getko						5.61									5.61
Gold	5.45						6.12						5.17		5.61
Golden										5.45					5.45
Golden-1						5.71	6.11								6.01
Hira	5.38	5.74	6.09	5.76	4.95				5.90			6.33	5.15		5.78
Hira-16							6.34			5.64			5.61		5.95
Hira-2		5.89				5.39			5.44				5.05		5.27
Hira-5													5.18		5.18
Hira-6						5.45					6.44			6.38	6.09
Hybrid dhan-10			6.21												6.21
Ispahani					5.39	5.83		5.49					4.85		5.30
Ispahani-1													5.15		5.15
Ispahani-2						5.45		6.59					5.17		5.62
Ispahani-6								6.67							6.67
Ispahani-7						5.53									5.53
Jagaron						5.61							5.17		5.31
Jamuna										5.30			5.35		5.33
Janakraj		5.97	6.21			5.27				7.45			5.21		6.02
Jhalak								6.48							6.48
KBP-1									6.06						6.06
Krishak-2													5.14		5.14
Krishan								5.45							5.45
Krishibid seeds		5.76				5.45			6.05				5.17		5.61
Lal teer								6.52					5.21		5.86
Madhumoti								5.45							5.45
Madhumoti-5							6.14								6.14
Mahi Gold										5.72					5.72
Mahico		4.55		5.65									5.24		5.15
Mahico-1							6.39	6.47							6.43
Mitali				5.68					4.85						5.27
MJ-0032								6.06							6.06
Moharaj		6.06								5.65					5.86
Moina			6.29			5.30	6.14						5.02		5.46
Mongal		5.30			6.06										5.68
Monihar													5.15		5.15
MS-1									5.83				5.17		5.50
Mukti													5.00		5.00
Mukti-1			6.32			5.47			5.86	5.68			4.83		5.50
Mukti-2										5.53					5.53
Nafco-108						5.56							5.34		5.39
National							6.21								6.21
National Agri care													5.15		5.15
Nilsagor								6.45							6.45
Nobin						5.61		6.36		5.64			4.70		5.58
Other		4.92	6.21				5.23								5.45
Pacific													5.45		5.45
Patex		5.45						5.30					5.45		5.40
Patex-1													5.15		5.15
Petrokom					5.56										5.56

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Pioneer-12					5.64										5.64
Pioneer-14													5.00		5.00
Power										5.76					5.76
Rajkumar			6.21										5.11		5.66
Rupali		5.50							5.15				5.23		5.29
Rupshi Bangla													5.15		5.15
Rupshi-4						5.35									5.35
Sakka				5.45										6.36	5.91
Sampad		6.27	6.14				6.06	6.36		5.38		6.36	5.68		6.04
Sathi	5.45	6.06	6.21			5.64			5.24				5.09		5.50
Shakti		5.86	6.14										5.14		5.82
Shakti-2						5.70	6.14						5.17		5.79
Shera				5.15	6.06					5.26				5.42	5.47
Sinjenta		5.86			5.25					5.73					5.63
Sinjenta-1201							6.00	6.05					4.85		5.83
Sinjenta-1202					6.06		5.95	5.74							5.92
Sinjenta-1205						6.06							5.14		5.60
Sinjenta-1206										5.49					5.49
Sinjenta-1210							6.02								6.02
SL Super													5.76		5.76
Sonar Bangla	5.30	6.06				5.52					6.44		5.08		5.51
Subarna													5.67		5.67
Sura													5.17		5.17
Surovi		5.80													5.80
Suvra			6.21												6.21
Tinpata				5.64		5.61							5.17		5.51
Uni-207								5.82							5.82
Win-270											6.36				6.36
Win-868						5.15									5.15
Winall Hi Tech Seed			5.30												5.30
ACI-1	5.76					5.67							5.38		5.51
ACI-2	5.38					5.64							5.19		5.38
Agro-12	5.53	5.96	6.06	5.79		5.73	5.68	5.84		5.83			5.15		5.78
Arize-7006	5.44	5.74	6.02	5.89	5.99	5.56	5.88	6.01	6.06	5.72	6.45	6.06	5.19	6.05	5.86
Dhani Gold		5.97	5.82	5.60	5.59	5.73	6.20	6.24	6.30	5.77	6.45	6.44	5.41	5.53	5.89
Hira-10						5.53			5.53				5.25	6.19	5.52
Pioneer		5.30	6.30	5.74		5.76			6.05	4.80		6.36	5.26		5.67
Sinjenta-1203				5.70	5.92	5.88	6.06	6.52		5.84	6.47		5.22		5.95
SL8H		5.76	6.21	5.95	5.60		7.16	5.76					5.14		6.06
Tej		5.73		5.71	5.54	5.85	6.21				6.43		5.19		5.81
Tej Gold		5.71	6.26	5.68	5.56	5.85		6.20	3.83	4.47			5.11	6.36	5.38
Tia		5.12	6.06	5.52		5.95	5.91			5.70		5.73	5.02		5.53
All Indian Varieties	**4.05**	**4.52**	**4.45**	**4.26**	**4.26**	**4.71**	**4.18**	**4.77**	**4.12**	**4.19**	**4.87**	**4.14**	**4.36**	**4.00**	**4.47**
Kajal								4.35							4.35
Madabi										4.47					4.47
Madabilata					4.38										4.38
Miniket		4.23				4.73		4.66							4.50
Molla Katari						4.58									4.58
Potalpairi		4.55													4.55
Ratna									4.09						4.09
Sampa Katari						4.38					4.76				4.57
Suballata								4.98							4.98
Lal Swarna								4.84							4.84
Mamun Swarna		4.55				4.48							4.18		4.37
Nepali Swarna						5.05							4.23		4.64
Sada Swarna								4.92							4.92
Sumon Swarna						4.77									4.77
Swarna Musuri			4.46	4.27		4.76				3.98		4.14			4.33
Swarna-5						5.03							4.34		4.57
Guti Swarna	4.05	4.58		4.24	4.25	4.89	4.18	4.80	4.13		5.26		4.48	4.09	4.50
Ronjit		4.64	4.41		4.20	4.50		4.82		4.29	4.47		4.33	3.90	4.39
Zira sail		4.36									4.71				4.59
Other MVs Total	**4.11**	**4.27**	**4.29**	**3.95**	**4.16**	**4.56**	**4.47**	**4.61**	**4.30**	**3.97**	**4.47**	**4.35**	**4.21**	**3.90**	**4.31**
Abdu Guti											4.76				4.76
Abdul Hye	4.53														4.53
Asami														4.17	4.17
Basmoti						3.21									3.21
Bhojan	3.79								4.23						4.01
Bogura sampa						4.77									4.77
Borna						5.03				4.09			4.09		4.40
Chaon		4.55													4.55
China													4.17		4.17
Golden Atab											2.88				2.88
Gota IRRI	4.17		4.03												4.12
Grson						4.09									4.09
GS-1								4.66							4.66
Habu dhan								4.27							4.27
Hutra											5.45				5.45
IRRI sail												3.79			3.79
IT									4.18						4.18
Jamaibabu									4.39				4.20		4.32
Jotapari						4.92									4.92
Kataribhog		4.42													4.42
Khato								5.02							5.02
Khato-10											4.67				4.67
Komal						4.32									4.32
Kotra						4.51									4.51
Nania						4.77									4.77
Naoga								3.71							3.71
Other		4.30	4.55				4.47			3.62			4.23		4.24
Pathargata						5.45									5.45
Porasmoni		4.55													4.55
Protik								4.36							4.36

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Purnima						4.32									4.32
Raich		4.24													4.24
Ranjana						4.52							4.12		4.32
Rupsha								5.15							5.15
Sakkapanja												4.32			4.32
Satabdi						5.05									5.05
Siattor						4.70									4.70
Sonali pajam												4.24			4.24
Sonamukhi						4.58									4.58
Sylheti pajam												4.41			4.41
Tepu	4.09														4.09
Hori dhan	3.79		4.34		5.55					4.30	5.15	4.98	4.22		4.47
Pajam	3.79	3.78	4.23	3.95	3.47					3.71	4.09	4.33	4.47	3.64	3.89
Parija						4.24							4.14		4.19
All LVs Total	**2.46**	**2.20**	**2.56**	**2.36**	**2.54**	**2.83**	**2.70**	**2.57**	**2.62**	**2.53**	**2.68**	**2.50**	**2.41**	**2.26**	**2.51**
Jul							2.95								2.95
Absaya					2.94					2.88					2.92
Agni	2.42														2.42
Agrani sail			2.61												2.61
Aguni/Agni			2.55	2.05								2.24			2.35
Akhani sail							1.68							2.23	2.05
Alebro			2.66												2.66
Aloi					2.74								2.65		2.68
Argoja	2.39														2.39
Arman sarder	2.37								2.53						2.42
Arparina							2.95			2.33					2.64
Ashfal									3.67						3.67
Ayna sail														2.27	2.27
Azdaha							3.03								3.03
Babuibhog													2.08		2.08
Badai	2.08						3.79								2.93
Badal														2.05	2.05
Badshabhog		2.12				2.64	1.80	2.20	2.38			2.36	2.37		2.29
Baismoti										2.62					2.62
Balam			2.42		2.91		1.63		2.48	2.58				2.26	2.23
Baonkhir	2.57														2.57
Basa												2.24			2.24
Basful Badam	2.22								2.76						2.43
Bashiraj		2.12					4.55								3.33
Basmoti													2.50		2.50
Baspair	2.53								2.56						2.55
Bazai							2.73								2.73
Bazal			2.41												2.41
Begunbichi		2.23								2.38			2.15		2.25
Benama										2.02					2.02
Benapol									2.63						2.63
Bennagour	2.64														2.64
Beti														2.08	2.08
Beti balam									2.65						2.65
Beti chikan	2.75		2.65												2.72
Beto													2.42		2.42
Bhog Dhan													2.27		2.27
Bhozan	2.27														2.27
Bilualaha							2.85								2.85
Bina sail					2.56		2.77						2.54	2.18	2.56
Binnaful											2.79				2.79
Binni	1.39		2.65	2.48	2.32					2.43		2.41	2.55		2.34
Biroi					2.60					2.40					2.50
Biroin														2.43	2.43
Birpala								2.82							2.82
Boari	2.52														2.52
Bodiraj										2.43					2.43
Bor Hafzi										2.75				2.29	2.59
Bora digha							2.73								2.73
Bosi		2.12													2.12
Bozramuri									2.80						2.80
Brindhi	2.67														2.67
Bushihara	2.95		2.52	2.02			3.05								2.72
Bute salute									2.70						2.70
Butia Pajam										2.32					2.32
Chanmoni										2.44		2.35		2.03	2.27
Chap sail	2.73				2.29				2.47						2.49
Chapail									2.61						2.61
Chapalni										2.38					2.38
Chaplas	2.29													2.27	2.28
Chata bazal				2.11											2.11
Chengermuri														2.20	2.20
Chengul											3.03				3.03
Chikan dhan												1.97			1.97
Chinapro												2.79			2.79
Chini		2.08					1.73		2.58		2.60				2.36
Chini sail										2.50					2.50
Chinigura	2.12		2.40	2.23	2.56	3.03	3.03		2.44			2.29	2.38	2.27	2.42
Chinikanai									2.55						2.55
Chinikatari						2.73									2.73
Chinisagor										2.59					2.59
Chollis zira						2.70									2.70
Chorboshor	2.69														2.69
Dalamota			2.73												2.73
Dalkachu	2.18									2.53	2.73				2.43
Dekibhog						2.88									2.88
Depa									2.09						2.09
Depo					1.67			2.52	2.45						2.32

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Digha								2.45	2.17						2.31
Dinga sail	2.30														2.30
Dud bazal				1.92											1.92
Dudmona	2.27						3.00								2.64
Dudmoni							3.18								3.18
Dudsor	2.55								2.70		3.03				2.66
Dulabhog													1.97		1.97
Ekar Chaul										2.31					2.31
Fariamota	2.95														2.95
Fulbadam	3.55														3.55
Fulgazi										2.61					2.61
Gabrail	2.48														2.48
Gacha			2.45	2.11			3.38								2.65
Gainja				2.58	2.91									2.18	2.56
Ganda Kosturi	1.82														1.82
Gandi sail					2.47										2.47
Garia													1.97		1.97
Gasani	2.42														2.42
Geromoti									2.68						2.68
Gigos			2.49	2.11					2.23			3.23			2.45
Gikosh	2.92														2.92
Goalgosh								2.20							2.20
Gocha								2.70	2.61						2.67
Golapi					2.42					2.58					2.50
Golok Khoiya	2.58														2.58
Gomti				2.67											2.67
Gonoveri					2.45										2.45
Gonshi									2.77						2.77
Gothak														1.97	1.97
Green sail			2.58												2.58
Guti IRRI														2.29	2.29
Guti Swarna	2.73			2.70	2.80										2.74
Haloi										2.49					2.49
Hargoja	2.58														2.58
Hashful					3.33										3.33
Hasim														2.18	2.18
Hawai				2.62											2.62
Hobigonj		2.21													2.21
Hoglapata	2.73								2.74						2.74
Holdi	2.44												1.97		2.28
Horibhog									3.64						3.64
Horkot									3.62						3.62
IRRI boz									2.27						2.27
Jabra							2.27		2.44						2.38
Jafor IRRI							2.65								2.65
Jamai													2.27		2.27
Jamri mota	2.02														2.02
Jinga sail							2.67								2.67
Jogdala											2.12				2.12
Joldepa													2.12		2.12
Jota						2.91									2.91
Jotabalam									2.86						2.86
Jotapari													2.47		2.47
Joyna	2.42								2.02						2.22
Jumur								2.62	2.53						2.58
Jur									2.55						2.55
Kachamou	2.42														2.42
Kainol										2.93					2.93
Kaisabinni					2.58					2.80					2.69
Kajal sail	2.34		2.69												2.48
Kala	2.80														2.80
Kalakhoi	2.05														2.05
Kalamadari							2.95								2.95
Kalamanik	2.42												2.42		2.42
Kalamota	2.65		2.39												2.58
Kalaraja					2.27										2.27
Kaligo			2.52												2.52
Kalo zira	2.29	2.14	2.62	2.43	2.41	2.80	2.18	2.06	2.37	2.29	2.46	2.30	2.45	2.31	2.38
Kamak kamani					1.77										1.77
Kamalamota	2.03														2.03
Karamcha											2.85				2.85
Kareng	2.35														2.35
Kartik balam	2.52								2.26						2.39
Kartik sail	2.37		2.52	1.98	1.91		2.73		2.70					2.06	2.38
Kasra									2.91						2.91
Kataribhog			2.32	2.66		2.86					3.13		2.23		2.67
Keymou	2.61														2.61
Kharamo	2.83														2.83
Khasa														2.73	2.73
Khejursori									2.76						2.76
Khek sail									2.70						2.70
Kheya	2.34														2.34
Khiloi					2.79										2.79
Khirkone								2.81	2.08						2.45
Khirsabhog													2.27		2.27
Khirsapat					2.00										2.00
Khondola			2.80												2.80
Khormonor	2.12														2.12
Khoto bada											2.32				2.32
Khurapoti					2.71										2.71
Koijuri									2.95						2.95
Korchamuri							2.02								2.02
Kuiamoni			2.20												2.20

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Kumra boilam			2.73												2.73
Kumragour	2.61								2.80						2.68
Kumri										2.58					2.58
Kuti Agrani	2.53														2.53
Kuti Angti							3.11								3.11
Kuti Chikan				2.21											2.21
Kuti sail	2.42														2.42
Laita										2.73					2.73
Lakhi digha	2.27						2.60								2.52
Lakhi Kajal			2.53					2.94							2.73
Lal					2.67										2.67
Lal Balam									2.71						2.71
Lal Chikan	2.43						2.95								2.50
Lal Gora													2.58		2.58
Lal Kartik	3.03														3.03
Lal mota	2.53								2.71						2.58
Lal Paika							2.82								2.82
Lal pajam			2.58												2.58
Lal Zira			2.71												2.71
Lamba Bhozan							2.00								2.00
Lati sail					2.42										2.42
Lator mota	2.42														2.42
Lebu sail							3.15								3.15
Leha Gorcha							2.85								2.85
Lohadong					2.42					2.76					2.59
Lohati					2.91										2.91
Lokma	2.59								2.73						2.66
Loti sail		2.27	2.47		2.03		2.39			2.40				2.20	2.32
Lotor			2.42												2.42
Madavilata										2.50					2.50
Madhu Sail					3.45		3.64								3.55
Madhumalti	2.58		2.58												2.58
Malanchi										2.36					2.36
Malsira													2.63		2.63
Malti sail					2.95					2.70				2.20	2.67
Master										2.58					2.58
Matichak	2.45														2.45
Megraj														2.06	2.06
Mesi sail					2.28										2.28
Modonga														2.30	2.30
Mogaibeti	2.88														2.88
Moinamoti	2.77						1.92		2.58						2.47
Moisamuri			2.53												2.53
Mon sail														2.32	2.32
Monohor								2.95	2.47						2.63
Montesor	2.73								2.47						2.65
Morish sail									2.80						2.80
Mota Chikan							3.18								3.18
Mota Malti										2.35					2.35
Motha Mota	2.55														2.55
Motihari			2.52												2.52
Moulta	2.48														2.48
Mukut													2.35		2.35
Mura Bazal			2.75	2.30											2.52
Muri Sail				2.06											2.06
Nagpachi			2.53												2.53
Naizer sail	2.86	2.39	2.57	2.27	2.66		2.46	2.56	2.62	2.70			2.61	2.44	2.55
Nakuchi Mota	2.45														2.45
Nalkosh	2.10														2.10
Naosa										3.03					3.03
Naringa							2.94								2.94
Naspati	3.18														3.18
Nayaraj										2.39			2.12		2.26
Nonakhorsi	2.44								2.50						2.48
Nunia						2.82							2.52		2.72
Other		2.21	2.73				2.65			2.30					2.47
Pajam				3.50			2.96						3.36	2.27	2.90
Palabir	2.73														2.73
Panisai													2.35		2.35
Panja			2.55												2.55
Pankais	2.48														2.48
Parbat zira														2.58	2.58
Pari													3.33		3.33
Parijat										2.89					2.89
Pat													3.33		3.33
Patjag		2.36			3.11										2.61
Patnai									2.27						2.27
Philiphin						2.94									2.94
Pipralais			2.55	2.05											2.30
Pirpi sail							2.88								2.88
Potalpairi													2.55		2.55
Rahman										2.54					2.54
Rai chikan			2.56												2.56
Raja Aman				2.70											2.70
Raja sail	2.41		2.56				3.18								2.56
Rajbhog					1.92										1.92
Rangamoni												2.09			2.09
Rani Salut									2.83						2.83
Rasulbhog													1.89		1.89
Roamodi										2.58					2.58
Ronjit				2.29	3.12					3.23				2.22	2.61
Rosmala										2.27					2.27
Sabar										2.58					2.58

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Sabarmal	2.64														2.64
Sada Balam									2.79						2.79
Sada Chikan	2.42						2.88								2.48
Sada Mota	2.55						2.64		2.64						2.58
Sagor	2.86														2.86
Saheb Chikan			2.64												2.64
Saila		2.33													2.33
Sailgirmi	2.12														2.12
Sakkapanja												2.27			2.27
Sakkarkhana	2.21		2.65						2.64						2.33
Salkani								2.58							2.58
Samna							3.20								3.20
Sampati							2.09								2.09
Sapahar		2.20								2.67			2.58		2.41
Satia													1.89		1.89
Satrabhog									2.71						2.71
Silkom		1.52					2.47								1.99
Sishumoti							2.72	2.52	2.65						2.65
Sita	2.33														2.33
Sona Digha							2.83								2.83
Sonamukhi					2.85										2.85
Sonar Bangla														2.09	2.09
Subarna lata									2.88						2.88
Sumaiya												4.41			4.41
Sunmoon										2.73					2.73
Swarna lata										2.42					2.42
Swarna Musuri	2.50			2.64											2.57
Tak sail									3.15						3.15
Tepa		2.27													2.27
Tepu sail	2.58						3.09								2.92
Til			2.42						2.35						2.39
Tilkabor					3.02								2.45		2.73
Tilok					1.97										1.97
Tula sail			2.42												2.42
Tulshimala				2.53	3.00					2.47				1.89	2.54
Uknimadhu													2.09		2.09
Urichidra									2.86						2.86
Uzal													2.50		2.50
Zira badam					2.42					2.54					2.50
Zira katari						2.88									2.88
Zira sail				1.92				2.38					2.22	2.15	2.18
Grand Total	**3.35**	**4.50**	**4.17**	**4.05**	**4.06**	**4.79**	**4.28**	**4.93**	**4.04**	**3.97**	**4.71**	**4.28**	**4.27**	**3.84**	**4.17**

(Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022)

Table E. Adoption (ha) of different Boro rice varieties by agricultural regions of Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BINA Varieties	**10671.5**	**1214**	**3807**	**1269**	**325.49**	**27**	**1694**	**3048**	**5718**	**878**	**302**	**576**	**1503**	**3304**	**34336.99**
Bina dhan-10	7492.5	119	1977	962	106.49		694	648	3688	413	20	105	729	1748	18701.99
Bina dhan-12									1			463			464
Bina dhan-14	13	355	952	282	176	27	585	700	1104	386	210	8	731	1528	7057
Bina dhan-17				25							5				30
Bina dhan-18	63						210				2		3	28	306
Bina dhan-19													40		40
Bina dhan-24					12					44					56
Bina dhan-5		70			1					35					106
Bina dhan-6					15			850			35				900
Bina dhan-7					15			850			30				895
Bina dhan-8	3103	670	878				205		925						5781
BRRI Varieties	**78746.5**	**235945**	**137951**	**272139**	**503327.5**	**170161**	**105500**	**206323**	**97955**	**450102.8**	**103617**	**11912.18**	**283219**	**345795**	**3002694**
BR1		100													100
BR10			73												73
BR11			300												300
BR12			750									120			870
BR14	56		1581		3097					1150			17307	3632	26823
BR15													412		412
BR16	15	3400	6505	5923	6	12261	134			510		197	11789	84	40824
BR19														2080	2080
BR2	835														835
BR26	26		720	75	940		78	1062	1410	10945		39		1027	16322
BR3	323			1888										732	2943
BRRI dhan28	11078	65572	36514	75527	135946	42852	14541	55714	53164	163156	47111	3110	91277	129130	924692
BRRI dhan29	9071	102195	22189	95553	303544	69863	55524	5551	2455	187891	24773	1491	63734	136733	1080567
BRRI dhan33		4805	3856			25		955				215	790		10646
BRRI dhan36		4060	285								3725	28			8098
BRRI dhan39			1494									283.2			1777.2
BRRI dhan45	75	290	80	445								140	1538	3483	6051
BRRI dhan47	16322		2170	490			860		106			35	190	34	20207
BRRI dhan48			6949	7596				1017			872			878	17312
BRRI dhan50	467	1848	1671	2040	3118	2515	3166	52363	5949	654.3	1686	143	3538	2836	81994.3
BRRI dhan55	362	94	5571	1280	150	185	845	387	51		153	507	366	2533	12484
BRRI dhan57								215			40				255
BRRI dhan58	1918	30917	17699	55899	41626	27045	18493	28821	9733	54899	9012	2966.7	42672	34260	375960.7
BRRI dhan59	292	363	88	40	6	314	287	70		560	10	51	670	251	3002
BRRI dhan60						30	465	17		80		17	1260	84	1953
BRRI dhan61	761			365	5		672			120	20		211	286	2440
BRRI dhan62	563	303	785	193		193	891	1195		780			40		4943
BRRI dhan63	22	1624	634	2289	1208	1059	1178	36245	3505	1215	1060	70	1613	1439	53161
BRRI dhan64	840	300	650	160	145	40	595	106	102	1080		28	329	1916	6291
BRRI dhan67	4799	231	8275	1832	1266	485	1795	1049	10261	4340	36	214.35	257	2010	36850.35
BRRI dhan68	61		834	164	5					1095		106		208	2473
BRRI dhan69	362	180	161	623	85	25				1106		346	1001	779	4668
BRRI dhan71		50													50
BRRI dhan72													25		25
BRRI dhan74	28997.5	4693	11474	8414	2962	4503	3815	3574	3321	7675	343	1274.08	23563	4945	109553.6
BRRI dhan75			1368	760											2128
BRRI dhan76													370		370
BRRI dhan81	144.5	7042	1228	2677	2940	4085	1001	14516	3500	2919	13374	118	9334	3532	66410.5
BRRI dhan84	77	855	1132	1204	488.5	2085	65	1241	711	1422	449	124	2370	3162	15385.5
BRRI dhan86		773	312	432	187	120	2	524	823	222	538	28.5	2446	470	6877.5
BRRI dhan88	117	1279	704	1766	1092	648	129	707	1637	2981	91	103.6	1549	3617	16420.6
BRRI dhan89	1162.5	4894	1650	3798	4365	1777	936	789	1175	5240	297	136.5	3549	4771	34540
BRRI dhan92		77	249	706	136	51	28	192	52	52.25	27	20.25	1019	883	3492.5
BRRI dhan96					10			13		10.25					33.25
Hybrid	**58800.5**	**37981**	**107623**	**53512**	**80863**	**48626**	**60515**	**52078**	**129728**	**205541**	**23948**	**12625**	**204932**	**124988**	**1201761**
ACI	5125	2110	6999	2661	4863	8419	4273	2382	8593	8755	1565	1116	19259	875	76995
Aftab	430		4452	1005	3092	2231	1510		1886	4461			1640	6242	26949
Agmoni	30		514	30	1394	20	155	1012	690	715	290	430	411	2754	8445
Agrani	150	220							605		285		855	2460	4575
Agro dhan-14	205		797	1413	569		85	1240	170	2025	1		694	368	7567
Aloran	1114	25	253		145		923	80	2943		110	741	2573	200	9107
Arize		150	848			1470	10	2226	2505	5696	350	17	590		13862
Babylon	590	460	710	1936	80	390	185		1703	950		602	2831	285	10722
Balaka	20		125		1330				120				40		1635
Balia	200		2739	700		300	720	690	815	1085			6411		13660
Bijoy	50					200	460								710
Bizli	240		650	390			85		65		100		185	160	1875
Brac/Brac-444	190				915			195	890	1565				2335	6090
Brac-777		482	40		40			375	752			50	590		2329
BRRI hybrid-1	51	100			100									50	301

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BRRI hybrid-2	105	15			156		2						519		797
BRRI hybrid-3	557.5				413				40				624	170	1804.5
BRS	60														60
Dhani gold	560	155	926		709	3580	5	90		2515	552		1474		10566
Doyal	40	100	45	200	1245					80				80	1790
Durbar	5347	550	682		500		525	5	655	115		64	520	125	9088
Falan	887.5	120	50				355		604	290			863	260	3429.5
Gold	1195	190	2750	335			1180		340	170			345	187	6692
Hashi	10									90					100
Hira	10023	6413	39401	12722	13147	6884	7271	5264	23894	34206	5230	2851	42154	29027	238487
Ispahani	4125	907	4339	340	2083	3279	1500	874	2473	9093	1285	1053	10049	655	42055
Jagaron	160	188	98		20	280	906		1224	500	215	120	1597	360	5668
Jamuna		10	230									17			257
Janakraj	914	110	1029	484	2584	2165	339		3369	10272	105	545	13443	25059	60418
Jhalak		35	220		80			92	90	2122	495		465	525	4124
Jubaraj	300														300
Kironmala	120		5				85								210
Kishan								5					90	110	205
Krishibid	180	140	197		534	385	75		690	7265	150		115	2609	12340
Lakpoti				300											300
Lalteer	10					455			351			486		180	1482
LP-106													10		10
LP-108										150			250		400
LP-50											40		75		115
LP-70				50							40		4055		4145
Malik							340				120		770		1230
Mitali		100				390		6	379	1490			529		2894
Modina	60								95	565					720
Moharaj		1402						5		1100			100		2607
Moina	3072	575	1726	212	110	788	305		1390	1140	615	167	4680	5556	20336
Mongal							649			45					694
Monihar							255						120		375
Nafco-108		30	5			85	821		445	695			2567	1335	5983
Nilsagor	284								10						294
Nobin	55		195			30		100	270	230		149	115	157	1301
Other	980	2682	5939	520	3950	3117	1144	2315	1857	2977	1526	263	8637	1973	37880
Panna	330						170								500
Partex	985	1154	764			452	1928	1114	818	1280	464		3434	1770	14163
Pioneer	80		570	265	563	575			1097	4595			2681	1414	11840
Quinal								230							230
Raicher	80	20	248				85			120	55		100		708
Rajkumar	1852	15	644			300	955	647	1539	50		151	445	1380	7978
Rajlakhi	340		141				170		540	835			560		2586
Rupali	824	1125	1418	2492	546	1045	235		1409	230	82	185	3095	6048	18734
Rupshi Bangla	40	20						250	223	316					849
Sacchal	235						465			2060				1000	3760
Sakka	10	1259		1449	5785	356	136	537	1184	11784	220	364	1720	2970	27774
Sampad	670	199	755	255	50	280	1321		130	1680	220		1040	180	6780
Sankor	30								18		650		40		738
Sathi	1634	320	632	2109	1563	1102	1450	410	3823	820	120	159	5602	65	19809
Shakti	826	557	1555	340	562	970	908	500	5073	2705	290	122	3210	555	18173
Shera	230		1569			325	20		483	790	125	108	2955		6605
Sinjenta-1201	840	4098			899	245	1139	1314	1308	17990		414	440		28687
Sinjenta-1203	354			5115	5610	1170	210	4222	10444				4052	1811	32988
Sinjenta-1204	100				20				383				190		693
Sinjenta-1205	108		2918	100	235	640		500	4572				9271	614	18958
SL-8H	8238	6821	13810	14251	15945	2074	22705	16369	22531	19752	3628	1383	17733	13825	179065
Sonar Bangla	1875	90	377						485	1610	220	194	1392	1025	7268
Suborna				21	95			980		61	75				1232
Sufula												182			182
Sugondha		573							65					3656	4294
Super hybrid						540				980		119			1639
Sura							340		285	360			206	500	1691
Surma			5												5
Suruvi			800		10				10				190		1010
Tej	1079.5	1766	966		1749	795	2797		4252		3359		4265	2409	23437.5
Tej Gold		2590		3017	4893	1771		6669	8231	33953		402	7811		69337
Tia	560	105	4487	800	4279	1518	493	1160	912	2853	1366	171	3650	1669	24023
Tinpata	40						825			355			605		1825
Unal								220							220
Indian Variety		38923				20715		5214	30		198744		940		264566
Pari						770									770
Parija		100									765				865
Ratna						450		1163	30						1643
Sampa Katari						11234					10490				21724
Zira											187489				187489
Zira sail		38823				8261		4051					940		52075
LVs	**3287**	**3472**	**703**	**120**	**2767**		**2375**		**249**	**788**	**15**		**1765**	**8013**	**23554**
Akhani sail														534	534
Amani boro					88										88
Ata sail					88										88
Ayna Mia														494	494
Begun bichi					1.5									36	37.5
Binni			481												481

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Biroin														205	205
Boala					1.5										1.5
Chaita boro	2489						144		80						2713
Chandani boro										43					43
Dali boro					51										51
Gochi										6				1473	1479
Jagali boro				15	109		237			64			538	197	1160
Kali boro	655			31	1110		1450		164	316			1079	58	4863
Kalo boro		2202													2202
Khoiya boro				7			150						102	1767	2026
Kunail					300										300
Lafaiya										49					49
Lakhai										25				833	858
Lal Dinga										25				145	170
Lal pajam			222												222
Lathi boror					17										17
Other	133			50	298		330			81			46	166	1104
Parbat zira														10	10
Pashu sail				15										78	93
Rata Sail					555					23				505	1083
Sada boro		1027													1027
Shaita	10	70					40								120
Solakia										71					71
Sonali boro							24								24
Sylhet boro									5						5
Tangoil				2											2
Tepi boro		173			123					85	15			1512	1908
Zira sail					25										25
OMVs	**11399**	**135437**	**8919**	**85**		**21461**	**2548**	**102148**	**6670**	**2282.2**	**36091**	**68**	**7840**	**3**	**334951.2**
Abdul Hye	185														185
BAU-3										0.2					0.2
Benumber	150		260												410
Bhozan	4365						1822		72						6259
Gol dhan			653												653
Gota IRRI	380														380
GS-1								510							510
Hutra											60				60
Iratom-40	734		4304												5038
ITE								725	954						1679
Jamaibabu									1430						1430
Kajal Lata		4660						4348	80		90				9178
Kajla IRRI	966														966
Katari											26180		6020		32200
Kataribhog		76890						111			50				77051
Khato Babu								15042							15042
Khato bhozan	3757														3757
Khato Das											5606				5606
Lal dhan			1254												1254
Lamba bhozan	632														632
Miniket		42467				16287		48956	2163				1045		110918
Nania						805									805
Other	80	5476	2176	85		2319	726	279	1	31	3005		775	3	14956
Pajam			11							1476					1487
Parash		650													650
Potal pairi		480													480
Purbachi	50	150	261							775		68			1304
Russion zira kapli						2050									2050
Suballata		4664						6570	1740		900				13874
Subarnalata								25607	230						25837
Sumsu											200				200
Sylhet IRRI	100														100
Grand Total	**162904.5**	**452972**	**259003**	**327125**	**587283**	**260990**	**172632**	**368811**	**240350**	**659592**	**362717**	**25181.18**	**500199**	**482103**	**4861863**

(Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022)

Table F. Average yield (t/ha) of different Boro rice varieties by agricultural region in Bangladesh, 2021-22

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
BINA Varieties	**5.64**	**5.76**	**5.70**	**5.78**	**5.70**	**5.63**	**6.43**	**6.21**	**5.79**	**5.73**	**6.30**	**5.65**	**5.76**	**5.08**	**5.81**
Bina dhan-10	5.84	6.03	5.77	5.95	5.75		6.48	6.37	6.00	5.73	6.06	5.56	5.66	5.71	5.92
Bina dhan-12									4.55			5.78			5.37
Bina dhan-14	5.00	6.13	5.61	5.61	5.78	5.63	6.37	6.10	5.88	5.85	5.95	5.68	5.95	4.36	5.72
Bina dhan-17				5.76							5.76				5.76
Bina dhan-18	6.37						6.46				7.58		6.06	5.47	6.41
Bina dhan-19													5.15		5.15
Bina dhan-24					6.20					5.56					5.81
Bina dhan-5		3.70			5.56					5.76					5.01
Bina dhan-6					4.85			6.06			6.36				5.91
Bina dhan-7					4.85			6.06			6.36				5.76
Bina dhan-8	5.52	5.91	5.74				6.28		5.79						5.71
BRRI Varieties	**5.72**	**5.91**	**5.71**	**6.07**	**6.06**	**6.49**	**6.49**	**6.12**	**5.78**	**5.93**	**6.70**	**5.80**	**5.94**	**5.78**	**6.00**
BR1		6.06													6.06
BR10			5.70												5.70
BR11			5.45												5.45
BR12			5.38									5.50			5.46
BR14	5.62		5.80		5.66					5.45			4.66	5.57	5.36
BR15													5.47		5.47
BR16	5.56	6.67	7.65	5.80	5.30	6.64	6.57			5.32		5.62	5.73	5.83	6.36
BR19														5.50	5.50
BR2	5.58														5.58
BR26	5.77		7.10	5.31	5.88		6.59	5.51	0.51	5.59		5.64		5.74	5.56
BR3	5.71			5.58										5.67	5.66
BRRI dhan28	5.53	6.42	5.50	5.72	5.30	6.25	6.17	5.94	5.94	5.74	6.54	5.53	5.80	5.55	5.81
BRRI dhan29	5.79	6.85	5.80	6.50	6.34	6.83	6.66	6.61	6.27	6.32	7.03	6.03	6.69	6.27	6.41
BRRI dhan33		5.99	5.03			6.18		6.36				5.06	5.79		5.69
BRRI dhan36		5.53	4.00								6.52	5.74			5.44
BRRI dhan39			5.16									5.62			5.50
BRRI dhan45	5.68	5.30	8.26	5.45								5.76	5.57	5.57	6.00
BRRI dhan47	5.56		4.18	6.48			6.29		5.45			5.56	5.84	5.84	5.41
BRRI dhan48			5.50	5.61				6.41			6.29			5.50	5.84
BRRI dhan50	5.52	6.30	5.20	5.74	5.71	6.22	5.93	6.20	5.80	5.50	6.17	5.63	5.73	5.19	5.77
BRRI dhan55	6.14	6.17	5.45	5.82	6.29	6.20	6.69	6.02	5.91		6.09	5.63	5.84	5.84	5.93
BRRI dhan57								6.14			6.06				6.10
BRRI dhan58	5.76	6.45	5.75	6.28	6.25	6.64	6.55	6.63	5.92	5.97	6.85	5.83	6.14	5.75	6.20
BRRI dhan59	6.40	6.13	5.70	5.87	6.32	6.44	6.06	7.21		5.89	6.36	5.52	6.03	5.83	6.05
BRRI dhan60						6.29	7.66	6.42		5.61		5.61	6.09	5.83	6.33
BRRI dhan61	5.27			6.02	6.06		6.21			5.76	5.91		6.14	5.82	5.83
BRRI dhan62	5.53	5.83	5.48	5.84		5.91	6.43	5.76		5.77			6.06		5.88
BRRI dhan63	5.30	0.00	4.12	5.85	5.90	6.28	6.33	6.43	5.92	5.72	6.54	5.74	5.81	4.52	5.37
BRRI dhan64	5.68	6.06	5.76	6.02	5.76	6.52	6.68	5.76	5.69	5.92		5.63	4.69	5.89	5.79
BRRI dhan67	5.52	0.00	5.67	6.02	5.76	6.60	6.26	6.18	5.81	6.01	6.56	5.76	5.46	5.60	5.77
BRRI dhan68	5.93		5.77	5.89	5.76					5.98		6.13		5.46	5.83
BRRI dhan69	5.76	6.30	5.35	5.91	5.27	6.21				6.08		5.87	5.63	5.69	5.82
BRRI dhan71		6.82													6.82
BRRI dhan72													5.82		5.82
BRRI dhan74	5.93	6.52	5.80	6.29	6.02	6.51	6.50	5.20	5.80	6.18	6.61	5.97	6.24	5.77	6.05
BRRI dhan75			5.74	6.22											5.90
BRRI dhan76													5.58		5.58
BRRI dhan81	5.71	6.63	5.77	6.05	5.84	7.07	6.48	6.44	5.87	5.75	7.69	5.77	5.88	5.85	6.17
BRRI dhan84	6.05	6.51	6.10	6.26	5.98	6.92	6.36	4.90	5.98	5.50	6.52	6.14	6.04	5.81	5.96
BRRI dhan86		6.45	5.71	6.23	5.79	6.92	6.82	5.89	5.96	5.97	6.64	6.27	6.37	6.06	6.15
BRRI dhan88	5.68	6.37	5.82	6.24	6.20	4.70	6.53	6.32	5.97	6.21	6.66	5.82	6.42	6.03	6.11
BRRI dhan89	6.05	6.66	5.98	6.55	6.80	7.58	6.89	6.44	5.92	6.74	6.99	6.49	6.64	6.97	6.59
BRRI dhan92		6.52	6.13	6.92	7.11	7.35	6.94	6.32	5.65	6.37	7.09	6.37	6.68	6.91	6.69
BRRI dhan96					6.68			6.51		6.36					6.54
Hybrid	**7.27**	**7.57**	**7.22**	**7.06**	**7.26**	**7.20**	**7.69**	**6.95**	**6.93**	**7.36**	**8.08**	**7.06**	**7.25**	**7.07**	**7.27**
ACI	6.10	7.77	8.70	7.17	7.30	7.04	7.91	6.26	7.35	7.33	8.00	6.97	7.40	7.22	7.25
Aftab	7.56		7.08	6.59	7.40	6.95	8.09		0.00	7.40			7.35	7.23	6.37
Agmoni	7.58		7.15	6.67	7.54	7.27	8.18	7.52	7.24	7.28	7.88	7.03	7.13	7.20	7.33
Agrani	7.88	8.06							7.30		7.50		7.73	7.15	7.54
Agro dhan-14	6.44		7.46	7.35	7.29		7.69	7.16	7.12	7.33	7.58		7.13	7.09	7.23
Aloran	7.00	7.15	3.64		6.76		8.04	7.42	5.91		8.03	7.02	7.34	7.01	6.70
Arize		7.27	7.23			7.23	7.73	7.58	7.28	7.55	8.11	7.12	7.24		7.44
Babylon	7.50	7.40	7.33	7.23	7.54	7.86	8.00		7.23	7.57		6.89	7.29	7.00	7.35
Balaka	7.58		7.39		7.58				7.27				7.42		7.45
Balia	8.03		7.42	7.48		6.57	8.15	7.71	7.29	7.38			7.30		7.41
Bijoy	7.42					7.27	7.98								7.56
Bizli	7.73		7.28	7.49			8.13		7.27		8.48		7.02	6.91	7.56
Brac/Brac-444	7.76				7.73			7.30	7.34	7.49				7.18	7.43
Brac-777		7.33	7.12		7.58			7.89	7.24			7.09	7.47		7.36
BRRI hybrid-1	7.90	7.22			7.42									7.24	7.40
BRRI hybrid-2	6.55	7.77			6.87		0.00						7.39		6.22
BRRI hybrid-3	4.57				7.17				7.20				7.54	7.07	6.45
BRS	7.58														7.58
Dhani gold	4.29	7.58	7.38		4.92	7.50	7.27	7.39		7.34	8.32		7.29		7.10
Doyal	7.73	7.27	7.34	7.45	6.96					6.97				7.08	7.19
Durbar	7.16	7.41	7.30		6.82		8.08	7.58	7.31	7.40		6.92	7.12	7.15	7.23
Falan	7.53	7.80	7.42				8.03		7.18	6.84			7.42	7.14	7.36
Gold	7.88	7.60	7.73	7.50			8.07		7.40	7.16			7.47	7.04	7.61
Hashi	7.58									7.39					7.45
Hira	7.19	7.84	7.17	7.27	7.33	6.20	7.90	7.43	7.35	7.43	8.09	7.17	7.32	7.21	7.36
Ispahani	7.19	7.49	7.05	7.16	7.66	7.37	8.17	2.61	7.40	7.23	7.91	7.02	7.37	7.11	7.02
Jagaron	8.16	7.57	7.19		7.73	7.32	8.06		7.29	7.19	7.95	7.27	7.17	7.05	7.42
Jamuna		7.27	7.34									6.72			7.01
Janakraj	8.38	7.58	12.79	7.34	7.58	7.61	8.18		7.38	7.35	7.95	7.10	7.45	7.14	8.12
Jhalak		7.14	7.12		7.58			7.74	6.92	7.32	8.03		7.27	7.15	7.33
Jubaraj	7.73														7.73
Kironmala	7.46		7.27				7.95								7.56
Kishan								0.00					7.05	7.19	4.75

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Krishibid	7.42	7.22	6.99		7.80	7.21	7.94		7.31	7.49	7.94		7.05	7.28	7.37
Lakpoti				7.47											7.47
Lalteer	7.88					6.88			7.09			6.68		7.09	7.01
LP-106													6.97		6.97
LP-108										7.35			6.97		7.16
LP-50											8.03		0.00		4.02
LP-70				0.00							8.03		7.58		5.20
Malik							7.95				8.93		7.20		7.69
Mitali		7.32				8.18		0.00	6.84	7.49			7.38		6.65
Modina	7.58								7.26	7.46					7.45
Moharaj		7.47						7.88		6.75			6.89		7.25
Moina	6.96	7.34	7.13	7.48	7.27	6.74	8.02		7.20	7.23	8.06	7.13	7.28	7.20	7.27
Mongal							8.08			7.58					7.83
Monihar							8.03						7.05		7.54
Nafco-108		7.12	7.27			6.97	8.14		7.24	7.34			7.33	7.06	7.29
Nilsagor	6.31								6.67						6.43
Nobin	7.71		7.41			0.00		8.24	7.37	6.92		7.18	6.97	7.20	6.76
Other	7.67	7.73	7.15	7.20	7.58	7.36	8.01	6.22	7.34	7.40	8.11	7.16	7.45	7.19	7.34
Panna	7.88						8.03								7.95
Partex	8.01	7.65	3.66			10.08	5.85	6.93	7.26	7.40	8.05		7.38	7.14	7.25
Pioneer	7.73		7.37	7.50	7.51	7.69			7.21	7.52			7.23	7.29	7.41
Quinal								7.73							7.73
Raicher	7.42	7.12	3.58				8.09			7.63	8.04		7.09		6.57
Rajkumar	8.21	7.27	7.36			7.27	7.98	7.72	7.21	7.27		7.19	7.08	7.25	7.44
Rajlakhi	8.18		7.35				7.88		7.09	7.46			7.31		7.50
Rupali	6.63	7.71	6.20	7.25	7.33	7.41	7.88		4.83	7.18	7.85	7.17	7.36	6.76	6.94
Rupshi Bangla	7.73	7.42						7.70	7.37	7.49					7.50
Sacchal	7.96						8.07			7.47				7.15	7.58
Sakka	7.27	7.72		7.16	6.97	6.77	8.00	7.39	7.41	7.51	8.07	7.16	7.27	5.42	7.13
Sampad	7.88	7.23	7.17	5.79	6.36	7.27	7.74		7.12	7.44	8.03		7.27	7.15	7.25
Sankor	7.58								7.41		8.18		7.20		7.59
Sathi	7.74	7.75	7.19	7.46	7.57	7.18	5.33	7.61	5.97	7.34	7.88	7.23	7.22	7.20	7.09
Shakti	7.78	7.51	7.26	7.11	7.70	7.18	7.87	7.82	7.30	7.31	8.03	7.16	7.29	7.18	7.41
Shera	8.11		7.37			7.27	7.95		7.11	7.64	8.07	6.93	7.28		7.44
Sinjenta-1201	8.18	7.88			7.16	7.50	8.11	7.65	5.97	7.61		7.05	7.29		7.35
Sinjenta-1203	7.66			7.31	7.38	7.64	7.82	7.42	7.28				7.34	7.14	7.41
Sinjenta-1204	7.12				7.58				7.17				7.27		7.26
Sinjenta-1205	7.13		7.24	6.97	7.69	7.73		8.09	7.38				7.36	7.22	7.36
SL-8H	7.06	7.92	5.95	7.33	7.36	7.41	7.99	7.66	7.31	7.42	8.08	7.16	7.46	7.36	7.38
Sonar Bangla	7.80	7.27	7.21						7.29	7.20	8.03	7.23	7.34	7.17	7.35
Suborna				7.58	7.22			7.23		7.58	7.96				7.47
Sufula												7.00			7.00
Sugondha		6.36							7.13					7.18	6.97
Super hybrid						6.97				7.41		7.20			7.20
Sura							8.03		7.35	7.45			7.09	7.24	7.38
Surma			7.27												7.27
Suruvi			7.46		6.67				6.82				7.05		7.00
Tej	6.55	7.76	7.35		7.23	7.68	7.87		4.81		8.23		7.22	6.97	7.19
Tej Gold		7.72		7.25	7.46	7.13		8.09	6.90	7.21		6.81	7.34		7.33
Tia	7.83	7.43	7.21	7.46	7.20	7.04	8.05	7.40	10.87	7.30	8.19	7.35	7.26	7.23	7.68
Tinpata	7.73						7.95			6.42			7.44		7.23
Unal								7.80							7.80
Indian Variety		5.81				5.49		5.98	5.76		6.34		5.61		5.92
Pari						4.13									4.13
Parija		6.06									5.92				5.97
Ratna						6.52		6.06	5.76						6.11
Sampa Katari						6.24					5.98				6.07
Zira											6.72				6.72
Zira sail		5.73				6.41		5.91					5.61		5.82
LVs	**2.72**	**2.18**	**3.03**	**2.55**	**2.83**		**2.88**		**2.97**	**2.95**	**4.34**		**2.33**	**2.71**	**2.76**
Akhani sail														2.59	2.59
Amani boro					3.42										3.42
Ata sail					2.81										2.81
Ayna Mia														2.88	2.88
Begun bichi					2.17									2.57	2.37
Binni			3.03												3.03
Biroin														2.73	2.73
Boala					2.33										2.33
Chaita boro	2.68						2.58		3.03						2.69
Chandani boro										3.00					3.00
Dali boro					2.43										2.43
Gochi										3.54				3.19	3.31
Jagali boro				2.93	3.04		2.62			3.13			2.76	2.52	2.89
Kali boro	2.75			3.18	2.54		2.76		2.98	3.01			2.76	2.58	2.75
Kalo boro		2.85													2.85
Khoiya boro				2.81			2.58						2.91	2.62	2.68
Kunail					2.51										2.51
Lafaiya										3.00					3.00
Lakhai										2.91				2.65	2.71
Lal Dinga										3.03				3.17	3.10
Lal pajam			3.03												3.03
Lathi boror					2.85										2.85
Other	2.68			6.36	2.95		5.98			2.44			0.00	2.80	3.00
Parbat zira														2.58	2.58
Pashu sail				0.00										2.75	1.84
Rata Sail					3.08					2.96				2.85	2.98
Sada boro		2.60													2.60
Shaita	3.03	3.24					2.88								3.05
Solakia										2.97					2.97
Sonali boro							2.65								2.65
Sylhet boro									2.88						2.88
Tangoil				0.00											0.00
Tepi boro		0.00			2.88					2.93	4.34			2.52	2.48

Varieties name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	BD
Zira sail					3.33										3.33
OMVs	**5.67**	**6.13**	**5.52**	**6.17**		**6.40**	**6.23**	**6.25**	**5.75**	**5.70**	**5.99**	**4.96**	**5.77**	**5.79**	**5.93**
Abdul Hye	5.45														5.45
BAU-3										7.58					7.58
Benumber	5.45		5.00												5.23
Bhozan	5.48						6.13		5.32						5.78
Gol dhan			8.15												8.15
Gota IRRI	5.78														5.78
GS-1								6.52							6.52
Hutra											6.67				6.67
Iratom-40	5.76		5.01												5.20
ITE								7.69	5.56						6.63
Jamaibabu									5.84						5.84
Kajal Lata		5.99						6.10	5.70		3.20				5.29
Kajla IRRI	5.89														5.89
Katari											5.68		5.20		5.44
Kataribhog		6.22						6.22			6.52				6.28
Khato Babu								6.18							6.18
Khato bhozan	5.83														5.83
Khato Das											6.35				6.35
Lal dhan			5.68												5.68
Lamba bhozan	5.31														5.31
Miniket		6.04				5.92		5.98	6.04				5.95		5.99
Nania						6.56									6.56
Other	5.76	5.89	5.72	6.17		6.64	6.32	6.18	5.71	5.70	6.70		5.98	5.79	6.09
Pajam			5.65							5.22					5.33
Parash		7.27													7.27
Potal pairi		6.17													6.17
Purbachi	5.55	5.91	4.72							5.30		4.96			5.16
Russion zira kapli						6.47									6.47
Suballata		6.24						5.92	5.89		6.29				6.12
Subarnalata								6.62	5.93						6.39
Sumsu											6.06				6.06
Sylhet IRRI	6.06														6.06
Grand Total	**6.31**	**6.48**	**6.34**	**6.30**	**6.10**	**6.80**	**6.65**	**6.46**	**6.42**	**6.41**	**7.12**	**6.39**	**6.61**	**5.87**	**6.42**

(Note: R = Region, R1= Barishal, R2= Bogura, R3=Chattogram, R4= Cumilla, R5= Dhaka, R6= Dinajpur, R7= Faridpur, R8= Jashore, R9=Khulna, R10= Mymensingh, R11= Rajshahi, R12= Rnagamati, R13= Rangpur, R14= Sylhet and BD=Bangladesh, Source: Field survey and DAE 2021-2022)