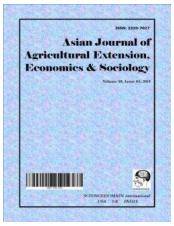

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How Does Adoption of Crop Variety Reduce the Impact of Drought in Agriculture and Mitigate Food Insecurity of Smallholder Farmers? A Case Study on BUdhan1 Rice Variety in Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Adaptation to climate change impacts in agriculture sector is a particular challenge in the coming decades. Erratic rainfall causes prolonged drought period in the north-western part of Bangladesh which hampers crop production and creates uncertainty of food security. Adoption of drought-tolerant crop variety could be an effective strategy to overcome the challenges of food insecurity. This study examines the adoption quotient of BUdhan1 rice variety and its effect on food insecurity status of the beneficiary

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farmers in Gaibandha district through a questionnaire survey of 60 sampled respondents. The results reveal that respondent farmers are slowly adopting BUdhan1 rice variety although they provided positive feedback regarding its profitability and attributive characteristics. The farm holding size, knowledge, access to information sources and annual household income was positively related to changes in the adoption of BUdhan1 rice variety. However, the productivity and economic returns from BUdhan1 influenced farmers' decision to continue or discontinue of the rice variety in the future. Notably, the study found a very significant impact of BUdhan1 adoption in eradicating food insecurity from the study area. This study highlighted some other strengths and weaknesses of BUdhan1 rice variety that can be included in the further development, multiplication and dissemination process of this rice variety to make it more climate-smart innovation.

Keywords: BUdhan1; adoption quotient; benefit-cost ratio; food security; drought; climate change.

1. INTRODUCTION

World population is projected to extend 8.6 billion in 2030, and 11.2 billion in 2100 [1]. The increased population will create a vast number of hungry mouths to feed with limited resources. Given that smallholder farmers are the significant portion of food-insecure group worldwide because of their over-dependence on natural resource-based farming such as rain-fed agriculture [2,3]. Moreover, global climate change is threatening the livelihoods of smallholder agricultural community by decreasing of farmland and crop production [4,5,6] as a result of climatic variability and natural disasters throughout the cropping season [7,8]. Reduced agricultural land will be impacted heavily in the areas where GDP is low, and people lead their livelihood with a limited alternative; such as agro-economy based country like Bangladesh [9,10,11]. Hence, it is very critical to develop sustainable adaptation pathways that could better withstand the climatic variability and extreme weather to sustain the food and livelihood security of the smallholder farmers.

In Bangladesh, rice is a principal staple cereal to 95% of the population. Among the cereal food grains, rice alone shares almost 80% of the total supply [12]. Almost 81% of the country's cropland is covered by rice which contributes to about 10% of national GDP [13] and a key determinant of food security [11]. However, production of rice is threatening in many climatically vulnerable regions of the country such as drought, salinity, and submergence prone areas. There are mainly three rice growing seasons in Bangladesh such as Aus, Aman, and Boro. However, a major share of production takes place during the Aman and Boro seasons [14]. People living in the northern region of the country mainly depends on aman rice as a significant source of their food supply. However, erratic rainfall is a prominent problem that caused prolonged drought and pose a direct threat to rice production. Hence, development of short durational rice variety that can withstand a certain level of drought and also avoid the period of extreme drought could be the most viable and adaptable way to mitigate food insecurity in this vulnerable region.

BUdhan1 developed by Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) in 2008 through crossing between KK8 and Badshabhug (Local Aman). This rice variety is resistant to drought and suitable for Kharif-2 (Aman) season. This rice variety is unique for the short durational character that it takes 85-95 days to maturity [15,16]. Thus, it took almost one month less than other existing rice variety and allowed the field to grow short durational crops like chili, mustard, potato, and other vegetables as relay cropping before the next season Boro rice [17]. Generally, after harvesting of Aman season rice, there is no scope for cultivating other crops before next season rice specifically in the Bengali month Ashwin and Kartik [18]. In this lean period, the farmer usually had no workload in the fields and alternative income generating activities which lead them to pass a precarious livelihood and causes massive migration to urban areas for searching short time jobs. The situation is more aggravated for the smallholder farmers and especially for the day laborers who even don't have any food storage for the lean period to support their dependencies [19]. Henceforth, BUdhan1 has immense potential to solve this poverty like situation through intensifying the cropping pattern and creating work facilities for the smallholder farmer and day laborers.

Studies conducted on BUdhan1 mostly confined to field level experiment and complete ignored socio-economic study for taking farmers feedback. Among them, [20] mentioned that incorporation of BUdhan1 in multiple cropping resulted in 8.4% yield increase and allowed

timely planting of next notified crops such as wheat and potato. A comparative laboratory study reveals that BUdhan1 has similar physical and cooking properties such as long grain and milling outturn like BRRIdhan39 [21]. The yield of BUdhan1 in the peak drought condition was recorded up to 4 tons per hectare which is similar to other popular rice varieties like BRRIdhan33 and BINAdhan7 [22]. Recently, it was [16] found that BUdhan1 provided comparatively higher grain (5.14 ton/ha), straw (5.79 ton/ha), biological (10.94 ton/ha) yield than other varieties such as BRRI dhan56, BRRI dhan57, and BINA dhan7.

Adoption of innovation is influenced by the perception of its user regarding attributes of the innovation which virtually remains unexplored in the case of BUdhan1 rice variety. Therefore, further study on BUdhna1 rice variety focusing on adoption and impact on food insecurity is an important area to provide farmers' feedback information to the policymaker and technology developer for better adaptation to the drought-prone areas. However, no study yet focused on to what extent farmers are adopting BUdhan1 rice verities and how is it contributing to eradicating the food insecurity in the northern region of Bangladesh.

The present study was conducted to minimize the gaps of inadequate information regarding the adoption rate of BUdhan1, its impact on food insecurity and more importantly the feedback of the farmers regarding strength and weaknesses of the rice variety. The finding of the study could be a handful for taking useful intervention measure to tackle the adverse effect of drought in the drought-prone northern region of Bangladesh. Notably, the technology developer and extension agent may find some guiding tools to make the rice variety technically appropriate and socially acceptable by the end users.

2. METHODOLOGY

2.1 Study Area and Sample Size

The study has been carried out in Gaibandha district (Fig. 1) which is well known as a typical drought-prone area of Bangladesh. BUdhan1 has been disseminated in different parts of Gaibandha district through DAE (Department of Agricultural Extension) and RDRS (Rangpur Dinajpur Rural Service). However, RDRS is playing a significant role in the diffusion process. Hence, upon consultation with RDRS personnel, Sadullapur and Gabindaganj upazila has been selected as a specific study location. A list of BUdhan1 beneficiaries has been collected from RDRS that constituted the population of this study. A simple random sampling technique has been followed to select 60 household heads who are cultivating BUdhan1 as the sample of the study.

2.2 Assessment of Farmers' Knowledge on BUdhan1

Knowledge of the farmers on BUdhan1 cultivation practices has been investigated through 15 questions under the dimension of awareness, how to, and principle knowledge as mentioned by Rogers [23]. A score of 0, 1 and 2 were assigned for the 'incorrect,' 'partially correct' and 'entirely correct' answers respectively [24].

2.3 Calculation of Adoption Quotient

Rogers [25] defined adoption as "a decision to make full use of an innovation as the best course of action available." In this study, adoption quotient has constructed by multiplying two indices namely extent and time for quantifying the adoption of BUdhan1 [26,27].

$$AQ = \frac{\{T_3 - (T_3 - T_2)\}}{T_3} \times \frac{\{T_3 - (T_3 - T_1)\}}{T3} \times \frac{A_1}{A_2} \times 100 \quad (1)$$

Where,

AQ = Adoption Quotient (%)
T1 = Time of introduction (year)
T2 = Time of awareness (year)
T3 = Time of first adoption (year)
A1 = Actual area under practice (hectare)
A2 = Potential area under practice (hectare)

2.4 Measurement of the Perceived Attributes Appropriateness Index (AAI)

The severity index as proposed by many researchers [28,29,30] is a widespread technique in climate change and other disciplines for measuring perceived severity and appropriateness of climatic shocks and adaptation measures respectively. We have developed an appropriateness index considering fourteen attributes of BUdhan1 that reflects its technical, economic, social, and cultural dimensions. A five-point Likert scale was applied to take into account the agreement of the

respondents where a score of 0,1,2,3 and 4 was assigned for 'strongly disagree,' 'disagree,' 'no opinion,' 'agree' and 'strongly agree' respectively. The AAI was calculated by following equation 2 [31].

$$\text{Attributes' Appropriateness Index (AAI)} = \frac{\sum_{i=0}^{4} p_i q_i}{\sum_{i=0}^{4} q_i} \quad (2)$$

Where pi represents the index of a class, qi represents the frequency of response, i.e., i= 0,1,2,3,4. The valuation procedure of the class was similar to Majid and McCaffer [29].

2.5 Estimation of Profitability

Profitability of BUdhan1 cultivation was estimated by computing BCR (Benefit Cost Ratio) [11,32].

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total cost}} \quad (3)$$

Where, total cost implies the cost of all inputs including cultural, intercultural and post-harvest operation and other expenses. Gross return represents the market value of harvested grain and straw of BUdhan1.

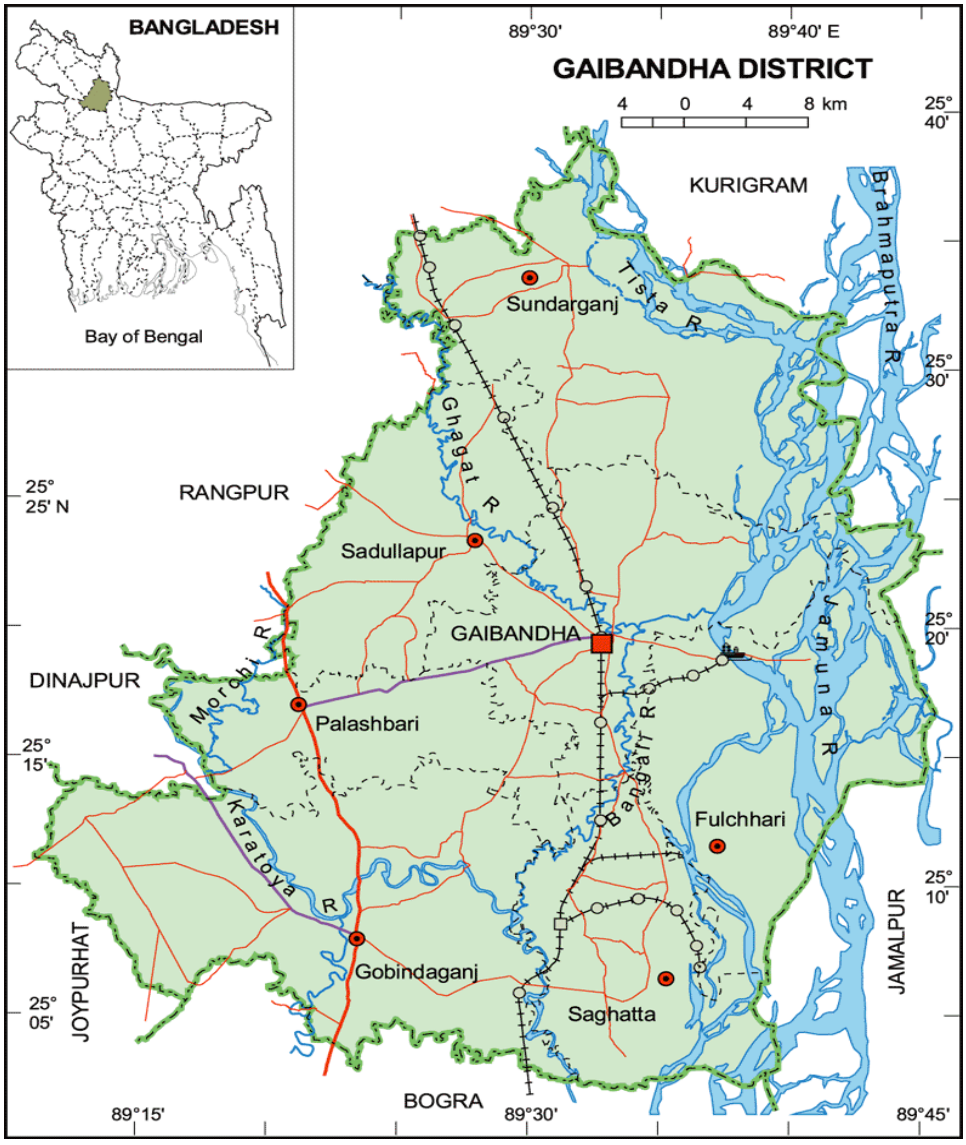

Fig. 1. A map of Gaibandha district showing study location

2.6 Impact of BUdhan1 Adoption on Mitigation of Food Insecurity

The relationship between adoption quotient and food security status has been explored through a chi-square test. Then, a contingency coefficient value was calculated based on the chi-square test result to see the degree of influence of adoption on reducing food insecurity of the BUdhan1 cultivators [33] following equation 4 and 5 respectively.

$$\chi^2 = \sum \frac{(F_0 - F_e)^2}{F_e} \quad (4)$$

Where,

F_0 = observed frequency
F_e = expected frequency
$\sum$ = summation sign

The contingency coefficient (C) was calculated as:

$$C = \sqrt{\frac{\chi^2}{\chi^2 + N}} \quad (5)$$

Where N = sample size

Adoption quotient value was categorized into 'low,' 'medium' and 'high' whereas food insecurity was categorized as 'not at all to slightly insecure,' 'moderately insecure' and 'extremely insecure.' This study categorized the food insecurity status of a household as 'not at all to slightly insecure' when that household had no rice shortage or a rice shortage of up to two months until the next harvest. It was regarded as the 'moderately insecure' when that household has a rice shortage of three to four months before the next harvest. Finally, a household was considered as 'extremely insecure' when it had rice shortage of five months or more before the next harvest. On the other hand, categorization of adoption quotient value was done based on the observed range and mean value.

2.7 Data Collection and Analysis

Primary data from the selected household heads were collected through interview methods. An interview schedule was constructed for gathering relevant information to satisfy the objective of the study. After the development of the interview schedule, it was then pre-tested with ten sample households randomly. The interview schedule was later finalized taking account of the experience of the pre-test. Selected respondents were then informed about the fixed plan of the interview process and confirmed with the help of SAAOs (Sub-Assistant Agriculture Officer) and RDRS personnel designated for the study areas. The interview process has completed from January to April 2016. After filling up the interview schedule by taking information from a respondent, it was cross-checked twice to avoid missing information. The collected data was then transferred to SPSS software to get the results of the study. Simple statistics like frequency, percentage, mean, range and standard deviation were analyzed to depict the results. Moreover, statistical analysis such as correlation, chi-square, and ANOVA tests was applied for testing the null hypotheses.

Hypothesis 1: There is no significant relationship between the socio-economic characteristics of the respondents and the adoption of BUdhna1 rice variety.

Hypothesis 2: Adoption of BUdhan1 has no impact on reducing food insecurity status of the respondent farmers.

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Profile of the Respondents

When a group of people is introduced with innovation, the different types of responses can be seen. Some people show positive response and accept the innovation very quickly while some others may perceive it negatively and reject finally. The social and economic background usually influence the decision of the people to accept or reject innovation. Hence, it is imperative to study the socio-economic background of the users in studying the adoption of technology and figure out the influencing factors. Results in Table 1 reveal that socio-economic characteristics of the respondent farmer showed marked individual differences among themselves which might have impacted on their adoption of BUdhan1 rice variety. The highest level of differences (range and Std. deviation) was found in the case of annual household income followed by age and knowledge. However, the lowest variance was found in the case of literacy and access to information sources.

3.2 Knowledge on BUdhan1 Cultivation

Since BUdhan1 is a newly introduced rice variety in the study area, understanding the production technologies of the rice variety by the farmers is essential for getting expected performance. Information displayed in Table 2 reveals that respondent farmers had a clear understanding of the time of planting, the name of the variety, seed rate, fertilizer application rate, suitable soil, and major insects. Results imply that different GO and NGOs effectively disseminated the information related to BUdhan1 cultivation. However, the inadequacy of knowledge was found regarding the optimum level of moisture, temperature, and relative humidity for storing BUdhna1 rice variety.

3.3 Comparative Area Coverage by BUdhan1

Rice is a staple cereal in the study area and to entire Bangladesh. Food security in Bangladesh mainly determined by the availability of and access to adequate rice [10]. Hence, adaptation to erratic-rainfall induced drought is a historical problem, and northern people are trying to adjust with different local and high yielding modern rice varieties. Data displayed in Fig. 2 reveals that BUdhan1, Gotisonna, Pariza, BRRI dhan28, BR11, and some hybrid varieties were mostly practiced in the study area. However, considering newly introduced rice variety, BUdhna1 covered almost 9% of the total rice cultivated area which implies that the relative position of the variety in the study area is yet to reach an expected level. In Bangladesh, BRRI dhan28 is one of the most adaptable rice variety irrespective of growing seasons and geographic areas which also reflected in a previous study [34].

3.4 Adoption of BUdhan1

The adoption quotient value of BUdhan1 ranges between 2.2 to 33.3 percent against a possible range of 0 to 100 percent. The highest majority (80%) of the respondents had an adoption quotient of 7 to 21% (Table 3) which implies that BUdhan1 is still in its early stage of diffusion in the study area and farmers were conscientious through the adoption process. It is very common that after the development of innovation or technology, it takes a certain period to reach its

Table 1. Descriptive statistics on socio-economic characteristics of the respondents

Variable	Unit	Range	Min.	Max.	Mean	Std. deviation	Variance
Age	Years	48.00	26.00	74.00	43.91	15.45	238.92
Literacy	Yes/No	1.00	1.00	2.00	1.90	0.30	0.09
Family size	Number	8.00	3.00	11.00	5.55	1.97	3.91
Farm size	Hectare	6.58	0.63	7.21	1.43	1.14	1.30
Annual income	Taka	552000.00	48000.00	600000.00	192128.83	152691.94	2.33
Access to information sources	Number	3.00	8.00	11.00	9.05	0.74	0.55
Knowledge on BUdhan1	Score	19.00	10.00	29.00	21.68	5.91	35.03
Area under rice	Hectare	5.64	0.37	6.01	1.32	1.41	2.01

Table 2. Farmers' knowledge of BUdhan1 cultivation

Sl	Questions related to BUdhan1 cultivation	Mean score	Level of knowledge
1	Name of two drought-tolerant rice variety	1.82	Adequate
2	Seed rate (kg/acre)	1.73	Adequate
3	Soil type	1.72	Adequate
4	Minimum number of seedling required per hill 3w99	1.25	Moderate
5	Optimum planting time	1.85	Adequate
6	Standard spacing	1.48	Moderate
7	The optimum rate of fertilizer application	1.73	Adequate
8	Name of two diseases that cause damage to BUdhan1 cultivation	1.51	Adequate
9	Name of two insects that cause damage to BUdhan1 cultivation	1.70	Adequate
10	Name of two pesticides & two insecticides	1.50	Adequate
11	Understanding the shattering problem	1.48	Moderate
12	The concept of good quality seed	1.32	Moderate
13	Number of splits in urea application	1.33	Moderate
14	Optimum temperature & RH for storage	0.75	Inadequate
15	The optimum level of moisture for storage	0.83	Inadequate
Overall mean		1.47	Moderate

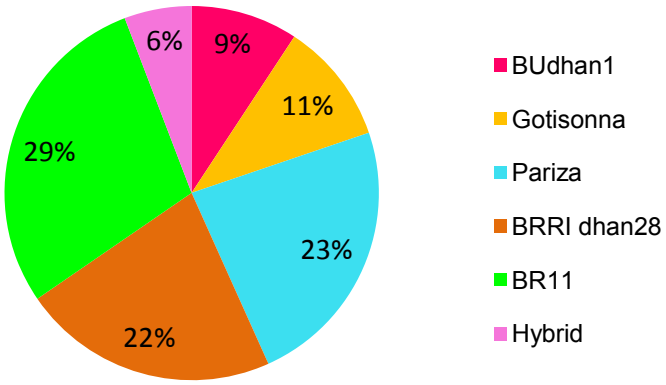

Fig. 2. The relative position of BUdhan1 in the study area based on area coverage

Table 3. Distribution of the respondents according to the extent of adoption of BUdhan1

Category	Respondents		Mean	SD
	Frequency	Percent		
Up to 7%	7	11.7		
Between 7% and 21 %	48	80.0	14.56	7.13
Above 21%	5	8.3		
Total	60	100.0		

Table 4. The relationship between adoption decision, yield, and profitability of BUdhan1

Decisions	Percent of respondents	Average yield (ton/ha)	Average BCR
Highly positive	25.0	3.70	2.06
Positive	35.0	3.81	1.55
Negative	23.3	3.49	1.10
Extremely negative	16.7	2.31	0.79
Total	100.0	3.46	1.45
F -value		14.22**	45.31**

***Significant at 1% level of probability*

take-off stage of diffusion. In Bangladesh, agricultural research is improving very faster in the last two decades and achieved the top position in the world regarding the generation of new crop varieties. So, new crop varieties are coming to farmers on a regular interval, and farmers are taking them in practice by comparing its relative advantage over the existing crop varieties that tendency might have influenced the low adoption of BUdhan1 in the study area.

3.5 Influences of Yield and Profitability of BUdhan1 on Farmers' Adoption Decision

Respondents' decision on BUdhan1 cultivation were assessed as 'highly positive,' 'positive,' 'negative' and 'extremely negative' by asking them whether they would like to increase, continue the same area, decrease area or completely stop BUdhan1 cultivation respectively in the next season or near future. Results in Table 4 reveal that almost 60% of the respondents were enthusiastic about BUdhan1 and they have the plan to extend BUdhan1 cultivation in future whereas almost one-fifth of the respondents showed a negative attitude towards BUdhan1 and wanted to stop its cultivation further. It is also evident from the Table 4 that both the yield and profitability had significantly influenced the decision of the beneficiaries where a favorable decision was influenced by higher yield and profitability, and an adverse decision was influenced by lower yield and less profitability. The results also reveal that there is a yield gap between farmer's field

(3.56 ton/ha) and the experimental field (5.14 ton/ha) [16].

3.6 Perception of Respondents on Attributes of BUdhan1

Adoption and diffusion of innovation are significantly influenced by some specific characteristics of the innovation such as relative advantage, compatibility, complexity, trialability, and observability [23,25,35]. In this study, we tried to focus on all these dimensions to see the appropriateness of BUdhan1 in describing innovation characteristics (Table 5).

Results in Table 5 reveal that AAI value (range) falls under 'agreed' opinion range which is 62.5 ≤ AAI< 87.5 implies that the performance of BUdhan1 concerning selected dimensions is satisfactory [28]. However, very exceptional performance of BUdhan1 was shortening the period of cultivation as got the highest positive feedback from the respondents (AAI = 86.25%). Moreover, BUdhan1 was successfully adapted with climate change as showed tolerance to drought (AAI = 77.50%) and provided higher yield (AAI = 76.28%) as opined by the respondents. So, this finding reveals that BUdhan1 has the potentiality to withstand climate-induced drought and better adapted with the local socio-cultural environment as well as ensuring food and livelihood security.

3.7 Factors Influencing Adoption of BUdhan1

Socio-economic status of the respondents has a profound influence on the diffusion and adoption of farming technologies [36]. Pearson's correlation test was employed to see how socio-economic characteristics of BUdhna1 cultivars influence their adoption behavior either positively or negatively (Table 6).

The correlation results (Table 6) show that some socio-economically important factor of the respondents has shown a significant positive relationship with their adoption behavior that implies concerned null hypotheses could be rejected and they have a significant positive influence on adoption behavior. The most significant factors that positively correlated with adoption was 'knowledge on BUdhna1 cultivation practices' as shown highest correlation value (r = 0.420**). Positive relation of knowledge and adoption of farming technologies also found in other studies [34,37,38]. On the other hand, farm holding size, access to information sources and annual income also showed a significant positive relationship with the adoption of BUdhan1and their correlation value was almost equal (0.246, 0.269 and 0.248 respectively). Adoption studies on different farming technologies also reported significant positive relation in the case of farm size [34,38,39], access to information sources [34,38,39], and annual income [34,38,39]. However, non-significant relations were also reported [34] in describing the relationship of farm size, access to information sources and annual income with the adoption of BRRI dhan47 in the coastal area of Bangladesh. Besides the characteristics mentioned above, age, level of education, family size and area under rice cultivation did not show a significant relationship either positively or negatively at 0.05 level of probability which disagrees with the findings of some previous study where education showed a positive relationship with the adoption of farming technology [34,37,38,39]. Hence, the concerned null hypothesis could not be rejected, and it may be concluded that none of these four characteristics had any significant relationship with the adoption of BUdhan1.

3.8 Impact of BUdhan1 Adoption on Farmers' Food Insecurity

Technological forecasting has played a tremendous role in eradicating food scarcity from many parts of the world, and it is worthwhile to mention the green revolution in the agricultural sector. So, in this study, efforts were made to figure out the impact of forecasting BUdhan1 in the northern region of Bangladesh to eradicate food insecurity of the cultivating farmers. A cross tabulation was done between adoption category and food insecurity status to depict the fact (Table 7).

The data presented in Table 7 reveal that more than 70% of the low adopter respondents were found extremely food insecure whereas 80% of the high adopter respondents were found not at all to slightly food insecure. The results indicate that there is a tendency of increasing food security with the increasing adoption rate of BUdhan1. Moreover, chi-square test result depicted a greater calculated value (χ^2 – cal=15.65) than the tabulated value (χ^2 – tab= 13.28; df=4) which implies that the adoption of BUdhan1 affected the food insecurity status of

the respondents. Furthermore, contingency coefficient value of 0.45** indicates that a 1% level increase of adoption of BUdhan1 may lead to a decrease of 0.45% food insecurity status of the respondents [33].

3.9 Problems Faced in the Cultivation of BUDhan1

BUdhan1 is a newly generated rice variety. Respondent farmers are cultivating this variety for the last two years. Hence, adapting this variety in the study area might need some improvement. In order for that, the top 10 perceived problems of BUdhan1 were identified through focus group discussion (FGD). Data presented in Table 8 revealed that majority (86.67) of the respondents opined damages caused by flood as the topmost problems of BUdhan1 cultivation followed by lack of sufficient seeds (76.67%), lack of training facilities (71.67%) and susceptible to diseases and pests (61.67%). Damages of BUdhna1 by floods also reported in Kurigram district of Bangladesh when conducted a field trial with 1000 farmers [17]. Hence, Bangladesh agricultural development corporation (BADC) and other NGOs should take the initiative for rapid multiplication of BUdhan1 seeds to meet up the demands. Further, the department of agricultural extension (DAE) should arrange training facilities for the farmers to develop their skill in BUdhna1 cultivation.

Table 5. Perceived Attributes' Appropriateness Index (AAI)

Sl.	Attributes	Response (%)					AAI (%)
		SA (4)	A (3)	NO (2)	D (1)	SD (0)	
1.	Short duration variety	73.3	6.7	11.7	8.3	-	86.25
2.	Drought tolerance	65.0	8.3	6.7	11.7	8.3	77.50
3.	High yielding variety	58.3	11.7	13.3	10.0	6.7	76.28
4.	Good taste	60.0	6.7	13.3	15.0	5.0	75.42
5.	Free from operational complexity	60.0	10.0	10.0	10.0	10.0	75.00
6.	Require less intercultural and post-harvest management	58.3	10.0	11.7	11.7	8.3	74.58
7.	Resistant to lodging	56.7	13.3	11.7	6.7	11.7	74.17
8.	Better grain quality	56.7	20.0	3.3	3.3	16.7	74.14
9.	Comparatively more profitable	56.7	11.7	11.7	10.0	10.0	73.75
10.	Higher market value	58.3	11.7	8.3	8.3	13.3	73.33
11.	Less number of dried grain per panicle	55.0	13.3	10.0	11.7	10.0	72.92
12.	Spectacular and eye-catching view of the rice field	51.7	16.7	10.0	13.3	8.3	72.50
13.	Require less seed	53.3	10.0	8.3	16.7	11.7	69.17
14.	Good quality straw	53.3	8.3	11.7	8.3	18.3	67.50

SA= Strongly Agree, A= Agree, NO= No Opinion, D= Disagree, SD= Strongly Disagree

Table 6. Relationships between socio-economic characteristics of the farmers and their adoption of BUdhan1

Independent variable	Dependent variable	The coefficient of correlation (r)
Age	Adoption of BUdhan1	-0.225
Level of education		-0.176
No. of family members		0.221
Farm holding size		0.246*
Access to information sources		0.269*
Knowledge of BUdhan1		0.420**
Annual household income		0.248*
The area under rice cultivation		0.238

*** Correlation is significant at 0.01 level of probability*

** Correlation is significant at 0.05 level of probability*

Table 7. Association between adoption of BUdhan1 and food insecurity among the respondents

BUdhan1 adoption category	Food insecurity status of the respondents			Total
	Extremely insecure	Moderately insecure	Not at all to slightly insecure	
Low	5 (71.4%) 35.7%	2 (28.6%) 8.3%	- 	7 (100.0%) 11.7%
Medium	8 (16.7%) 57.1%	22 (45.8%) 91.7%	18 (37.5%) 81.8%	48 (100.0%) 80.0%
High	1 (20.0%) 7.1%	- 	4 (80.0%) 18.2%	5 (100.0%) 8.3%
Total	14 (23.3%) 100.0%	24 (40.0%) 100.0%	22 (36.7%) 100.0%	60 (100.0%) 100.0%

χ^2 – cal=15.65; Contingency coefficient 0.455**

Table 8. Constraints faced in BUdhan1 cultivation

Sl.	Problem statements	Respondents (%)
1.	Damages of seedlings and planted crops by floods	86.67
2.	Lack of sufficient seeds	76.67
3.	Lack of training facilities	71.67
4.	Susceptible to diseases and pests	61.67
5.	Lack of credits and subsidies	58.33
6.	Higher production cost	31.67
7.	Lower market price during harvesting season	28.33
8.	Inconsistent yield performance	25.00
9.	Lack of proper land management technologies	18.33
10.	Mismatch with transplanting time	8.33

4. CONCLUSION

The results of the study indicate that a significant portion of the farmers in the study area had low to medium adoption of BUdhan1 rice variety where a differential level of adoption was influenced by the socio-economic differences such as knowledge, farm size, access to information, and the annual income of the beneficiaries. The adoption of BUdhan1 played a vibrant role to minimize food insecurity of the beneficiaries, and its attributes were found suitable for the study area. However, a considerable number of farmers those got lower yield, less profit and faced difficulties in the cultivation of BUdhna1 denied continuing its practice in the future. Hence, the developer of BUdhna1 rice variety and concerned extension agent should provide immediate attention to solve the limiting factors and make the rice variety more adaptable against drought vulnerability.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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