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Adoption Performance of IRRI Supported Submergence Tolerant Rice Variety in Bangladesh*

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Abstract *Submergence is a major problem for cultivating aman rice in many parts of Bangladesh. BRRI dhan51 is a rice variety which can withstand submergence for 10 to 14 days and still produce an yield of 4 to 4.5 tons/ha. The successful adoption of any variety may not be dependent just on its physical properties but also on its socio-economic acceptability. The objective of this study was to judge the profitability of BRRI dhan51 by comparing it with another local check variety- BR11. A total of 120 farmers were selected for having primary data from Rangpur and Mymensingh. The results observed that BRRI dhan51 cultivation was more profitable than BR11. The profitability analysis of BRRI dhan51 cultivation showed that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive and significant at 5 percent level of significance at Rangpur and Mymensingh. The study revealed that resistance to submergence, high yield, good taste and less fertilizers were the main reasons for adopting BRRI dhan51. The analysis also suggested that although adoption of the variety was more concentrated to sources of seed, farmers from distant places were also interested to grow it.*

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1. Introduction

Rice is the most significant crop in Bangladesh. It is the largest crop in terms of both area of production and value of production. Rice was cultivated in 76.23 percent of total cropped area during 2007-08 and it occupied 60.70 percent of gross value addition of crops during 2007-08 (BBS 2010). Among the three seasons for rice in Bangladesh, Aman is one of the most important seasons. The area coverage of Aman is the highest as a single crop in the country with 54,80,000 hectares of land being under Aman cultivation in 2009-10 season. It is also the second largest crop in the country, after Boro, in respect of the volume of production with 11152000 metric tons of production during the same season (BRRI 2012a).

Rice is also very important from consumption point of view in Bangladesh. It is the staple food for almost the entire population of Bangladesh. Rice consumption in this country is around 168 kg/capita/year, which is one of the highest in the world, and 76 percent of the food calorie intake for the people of Bangladesh comes from rice (IRRI 2011). The poor in Bangladesh spend a large part of their income on rice. The consumption of rice will continue to increase as incomes increase with growing urbanization. Rice is often regarded as a political commodity in Bangladesh (Sarwar, 2003). So, long term growth and stability in rice production, especially Aman and Boro production, is very crucial to ensure food security for the country in the long run.

However, the Aman season in Bangladesh is subject to natural disasters like flood which hamper its production and in some years damage the standing crops. Each year in Bangladesh about 26,000 km^2, (around 18%) of the country is flooded, killing many people and destroying homes, animals, crops and other properties. Aman rice is cultivated during the monsoon season when most of the flooding occurs. Monsoon floods from the major rivers generally rise slowly and the period of rise and fall may extend from 10 to 20 days or more. So, submergence is a major threat for Aman rice production. On this background, different international agricultural research organizations have been trying to develop submergence tolerant rice varieties. During 2010, Bangladesh Rice Research Institute (BRRI) in collaboration with International Rice Research Institute (IRRI) developed two submergence-tolerant varieties BRRI Dhan51 and BRRI Dhan52. The normal yield for these varieties is 5-5.5 tonnes per hectare, but when submerged for 10-14 days, the yield is still 4-4.5 tonnes per hectare (BRRI 2012b). So, these varieties can offset the damages caused by floods to a great extent.

The success for any variety in the field may not be dependent only on its physical properties or qualities. If a new variety fails to achieve socio-economic acceptability, it may not last long among the farmers. So, studying the profitability and socioeconomic acceptability of any new rice variety is very important. It is also worthwhile to study the adoption pattern of any such new variety in order to understand the obstacles in the adoption of such varieties in the field. Keeping these in mind, this study is an effort to judge the profitability of BRRI dhan51 by comparing it with another competitive rice variety and understanding the adoption scenario of BRRI dhan51. The other rice variety can be identified as competitive from economic perspective if farmers cultivate that during the same season using similar resources, irrespective of its genetic properties. In this study, the other variety under comparison is BR11. This variety is chosen because it is the most popular rice variety which is cultivated during the Aman season in the areas under study.

A number of studies were conducted on different aspects of new varieties adoption and economic comparison (BRRI, 2012b; IRRI, 2006; Jabbar, et. al., 1993 and Sarwer, 2003). While these studies made general conclusions about the adoption process of new varietyies, these did not emphase their economic aspect to the farmers. In addition to that there were little empirical insights into the magnitude of variety adoption. In this study, emphasis is laid on the economic aspect of the new variety. The specific objectives of the study are: to identify the socioeconomic profile of BRRI dhan51 and check variety (BR11) farmers; to compare the profitability of BRRI dhan 51; to observe the adoption patterns of BRRI dhan51; to track varietal adoption scenario of BRRI dhan51 in the study area; and to make policy recommendations for future.

2. Materials and method

Farm management research requires selection of an area where the research is conducted and related information is collected. Moreover, the area in which farm business survey is to be conducted depends on the specific purpose of the survey and the possible co-operation from the respondents. Keeping these in mind one village named Dhorsana under Rangpur district and three villages named Dharsa, Uttar Dunghata and Moddo Dungata of Mymenshingh district were selected for the present study.

Aman season generally begins in August and ends in November. To satisfy the objectives of the study, data on the costs and returns of BRRI dhan51 and BR11 for the two areas were collected using survey method in October 2011. At first,

lists of the farmers who produced BRRI dhan51 or BR11 in the study areas was taken. Then from those lists, 30 farmers growing BRRI dhan51 and 30 farmers of BR11 were selected randomly. So the total sample size was 120 from two districts. The final questionnaires for both locations contained three categories of information. The purpose of the first category was to obtain information about the socio-economic conditions of the selected farmers. The second category was to obtain information related to the costs and returns of the two selected rice varieties. The third category was to obtain information related to constraints and problems faced by the farmers in producing BRRI dhan51 and BR11 rice.

Analytical Techniques Used

All the collected data were checked and cross-checked before posting those to the Excel spread sheet. Thereafter the gathered data were classified, tabulated and analyzed in accordance with the objectives of the study. Tabular techniques were applied mostly to get arithmetic mean, averages, percentages and ratios. Farm business analytical techniques such as enterprises costing, gross margin analysis, etc. were performed to see the profitability of the enterprises. Finally, econometric technique such as Cobb-Douglas type revenue function was used to examine the effects of the independent variables on the dependent variables in the production of BRRI dhan51 and BR11 varieties of rice.

Econometric model specification: Cobb-Douglas Type Revenue Function

In order to estimate the effects of key variables in the BRRI dhan51 and BR11 rice production the Cobb-Douglas form of revenue function was used in the study (Gujarati, 1995). The specification of the Cobb-Douglas type revenue function for BRRI dhan51 and BR11 was as follows:

$$Y_i = aX_1^{\ b_1} X_2^{\ b_2} X_3^{\ b_3} X_4^{\ b_4} X_5^{\ b_5} e^{u_i}$$

In the Log Linear form it can be written as:

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + U_i$$

Where,

Y = Return per hectare in taka
X_1 = Human labor cost (Tk./ha)
X_2 = Seed cost (Tk./ha)
X_3 = Fertilizer cost (Tk./ha)
X_4 = Irrigation cost (Tk./ha)

X_5 = Hiring power tiller cost (Tk./ha)
a = Constant or intercept term

b_1, b_2, b_3, b_4, b_5 = production coefficient of the respective inputs variables to be estimated and

U_i = Error term

4. Results

Socioeconomic profile of the cultivating farmers

It can been seen in Table 1 that about 17 percent of the BRRI dhan51 farmers in Rangpur and 13 percent of the BRRI dhan51 farmers in Mymensingh fell into the less than 30 years of age group. It maybe noted that more farmers (53 percent) belonging to the middle aged group (30-40 years) cultivated BRRI dhan51, as opposed to 27 percent of the same group cultivating BR11 in Rangpur. Again, proportionately more farmers (60 percent) of higher age group (41 years and above) cultivated BR11, when a lesser proportion (30 percent) of the same age group cultivated BRRI dhan51. The figures indicate that younger farmers might have adopted BRRI dhan51 more than the relatively aged farmers. However, this was not true in case of Mymensingh where, the age distribution of farmers was similar for both the varieties.

Educational status of the respondents

To examine the educational status of BRRI dhan51 and BR11 growing farmers, the educational status of the sample farmers was divided into four categories.

Table 1 : Age distribution of the respondents

Age	Rangpur				Mymensingh			
	BRRI dhan51 farmers		BR11 farmers		BRRI dhan51 farmers		BR11 farmers	
	No.	%	No.	%	No.	%	No.	%
Less than 30 years	5	17	4	13	4	13	5	17
30-40 years	16	53	8	27	10	33	9	30
41 years and above	9	30	18	60	16	53	16	53
Total	30	100	30	100	30	100	30	100

Source: *Field Survey, 2010*

These were (i) illiterate, (ii) primary level (class I-V), (iii) secondary level (class VI to X) and (iv) above secondary level of education. Those who cannot sign**,** read and write were considered as illiterate. It is observed from the study that in Rangpur, 23 per cent of BRRI dhan51 cultivating farmers are illiterate, 20 per cent has primary education, 50 percent has up to secondary education and 6 percent has above secondary level education. On the other hand, these percentages for BR11 growing farmers are 18, 32, 45 and 5, respectively. In the case of Mymensingh, 27 per cent of BRRI dhan51 cultivating farmers are illiterate, 40 per cent has primary education, 27 percent has up to secondary education and 7 percent has above secondary level education. On the other hand, these percentages for BR11 growing farmers are 40, 37, 20 and 3, respectively. A significant fact to note from the table is that majority of the farmers (56 percent) at Rangpur, who cultivated BRRI dhan51 had educational qualification of secondary level or above. Also, at Mymensingh the BRRI dhan51 cultivating farmers were proportionately more educated than BR11 cultivating farmers (Fig. 1). So, higher education has a better role for adopting new variety of rice particularly in those areas.

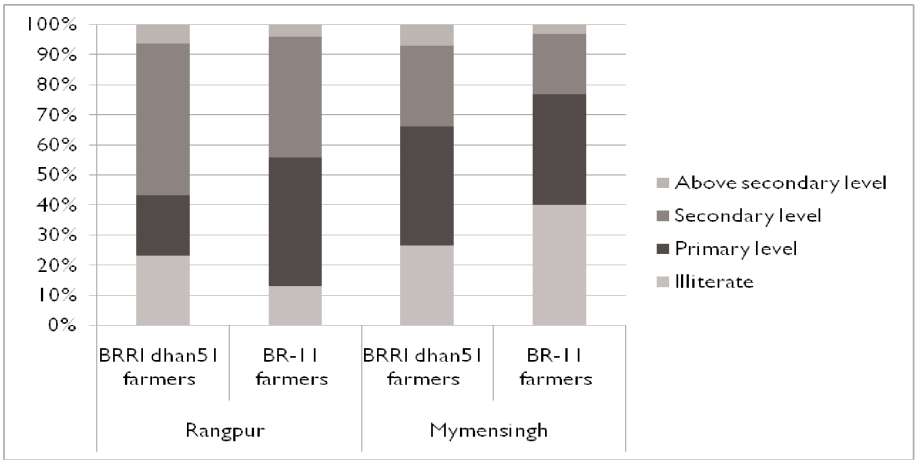

Fig. 1. Educational status of the respondents

Occupational status of sample farmers

Agriculture is the main occupation for majority of the selected farmers in this study (Table 3). Besides agriculture, some farmers are engaged in petty trading and others are employed in government, semi government or private services or

teaching. At Rangpur, in the case of BRRI dhan51 growers, 84 percent farmers are engaged in agriculture, 3 per cent in business and 13 per cent in service as their main occupation. In the case of BR11 growers, 67 percent farmers are engaged in agriculture, 23 percent in business and 10 percent engaged in service as their main occupation. The percentage of cultivators with agriculture as their main occupation is more in case of BRRI dhan51 growers (84 percent) as compared to BR11 growers (67 percent). It indicates that the true farmers are adopting new variety more than others. However, the situation is different at Mymensingh. There, the percentage of cultivators with agriculture as their main occupation is higher in the case of BR11 growers (86.67 percent) as compared to BRRI dhan51 growers (76.67 percent).

Table 3 : Primary occupation of sample farmers

Occupation	Rangpur				Mymensingh			
	BRRI dhan51 farmers		BR11 farmers		BRRI dhan51 farmers		BR11 farmers	
	No.	%	No.	%	No.	%	No.	%
Agriculture	25	83.33	20	66.67	23	76.67	26	86.67
Business	1	3.33	7	23.33	3	10.00	1	3.33
Service	4	13.33	3	10.00	1	3.33	1	3.33
Teacher	0	0.00	0	0.00	2	6.67	2	6.67
Fisher	0	0.00	0	0.00	1	3.33	0	0.00
Total	30	100	30	100	30	100	30	100

Source: *Field Survey, 2010*

Average farm size of the sample farmers

According to Yang (1965) farm size refers to the entire land area operated by the operator. It is measured by adding the area of land owned and the area of land rented-in from others and subtracting the area rented to others. It takes into account both the homestead area and the area used for woods, pasture and crops. In this research, the farm size of a farmer was measured by using the following formula:

Farm size = Homestead + own cultivable land + Rented-in land + mortgaged-in land - (Rented-out land + Mortgaged-out land).

The average farm size of the sample farmers are shown in Table 4.

Table 4 : Average farm size of selected farmers

Items	Rangpur		Mymensingh	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
Homestead (ha)	0.03	0.04	0.10	0.08
Farm land				
Owned	0.10	0.16	1.15	0.95
Mortgaged-in	-	-	-	-
Rented-in	0.50	0.29	0.26	0.29
Mortgaged/ rented out	-	-	-	-
Farm size (ha)	0.63	0.49	1.51	1.22

Source: *Field Survey, 2010*

Table 4 presents the average land ownership pattern and tenurial arrangements of selected farmers. It can be seen from the table that the average farm size is larger for the selected farmers of Mymensingh compared to the farmers of Rangpur. The average farm size is 1.51 and 1.22 hectares for BRRI dhan51 and BR11 cultivating farmers, respectively, at Mymensingh, while the average farm sizes for BRRI dhan51 and BR11 cultivating farmers at Rangpur are 0.63 and 0.49 hectares, respectively. Also there is difference in land tenural status of the farmers in the two regions. Although the data suggest that land is rented in both the regions for cultivation, the farmers at Mymensingh borrowed less land compared to their farm owned land while farmers in Rangpur borrowed more land compared to their owned land. However, in both the regions the average farm size is larger for BRRI dhan51 growing farmers as compared to BR11 growing farmers. It means the larger farmers are adopting this new variety of rice more than small farmers.

Per hectare yield of the sample farmers

The yield of BRRI dhan51 is higher in Rangpur than Mymensingh but the yield of BR11 is higher in Mymensingh than Rangpur (Table 5). One of the reasons is the frequent flooding in Rangpur area. Due to having higher submergence tolerance capacity, the BRRI dhan51 yield was higher than BR11 in Rangpur. On the other hand in Mymensingh, the yields of both varieties were similar.

Comparative profitability of BRRI Dhan51 and BR11 rice

This section attempts to estimate and analyze the costs and returns of producing BRRI dhan51 and BR11 in the two areas under the study in order to find out their

Table 5 : Average yield of the sample farmers

Items	Rangpur		Mymensingh	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
Main product yield (Kg/ha)	5004.44	3235.53	4649.84	4492.18
By-product (Tk./ha)	2062.8	1526.50	6664.04	4921.88
Price of main product (Tk./kg)	28.26	19.20	20.00	16.48

Source: *Field Survey, 2010*

comparative profitability. Full cost and cash cost have been considered in calculating gross cost. Cash cost includes all cash expenses while full cost includes all cash and non-cash expenses including land use cost and interest on operating capital.

By comparing the cost and return between the two districts for the two varieties, it can be seen from table 6 that BRRI dhan51 was found to be highly profitable at both the locations. However, BRRI dhan51 was more profitable in Rangpur compared to Mymensingh and it was due to higher yield and higher price of paddy. The farmers of both areas used this paddy as seed and that was the reason for higher price of BRRI dhan51.

Estimated econometric models

At Rangpur, the estimated Cobb-Douglas type revenue function for BRRI dhan51 was:

$InY_1 = 3.285 + 0.110\ InX_1 + 0.350\ lnX_2 + 0.202\ lnX_3 + 0.043\ lnX_4 + 0.215\ lnX_5$

Again the estimated production function for BR11 at Rangpur was:

$InY_2 = 1.480 + 0.107\ InX_1 + 0.220\ lnX_2 + 0.103\ lnX_3 + 0.028\ lnX_4 + 0.173\ lnX_5$

At Mymensingh, the estimated Cobb-Douglas type revenue function for BRRI dhan51 was:

$InY_1 = 3.835 - 0.077InX_1 + 0.117\ lnX_2 + 0.009\ lnX_3 + 0.\ 504\ lnX_4 + 0.485\ lnX_5$

And the estimated production function for BR11 at Mymensingh was:

$InY_2 = 1.\ 440 + 0.\ 662\ InX_1 + 1.139\ lnX_2 - 0.298\ lnX_3 - 0.470lnX_4 + 0.069\ lnX_5$

In the case of BRRI dhan51 cultivation at Rangpur, all the coefficients were

Table 6 : Comparison of Costs and Returns

Items	Value (Tk.)			
	Rangpur		Mymensingh	
	BRRI dhan51	BR11	BRRI dhan51	BR11
A. Gross Return	143488.27	63648.676	99660.84	78953.01
B. Variable cost				
Human labor	37003.52	32201.24	19378.14	23466.88
Power tiller	6036.87	5742.29	3702.68	2568.36
Irrigation	4814.01	4105.23	3643.53	2438.48
Seed	1469.2	2084.3	7144	844.75
Urea	2502.16	3298.21	1454.20	2457.03
TSP	-	4208.82	-	283
MP	-	1475.95	-	-
Miscellaneous cost	850.00	625.00	850.00	1500.00
Total variable cost	52675.76	53741.64	36172.55	33558.50
C. Fixed cost				
Interest on operating capital	1152.16	915.15	1100	915
Land rental cost	2093.00	1529.00	1750	1500
Total Fixed cost	3245.16	2444.15	2850	2415
D. Gross cost (B+C)	55920.92	56185.79	39022.55	35973.50
E. Gross margin (A-B)	90812.51	9907.036	63488.29	45934.51
F. Net Return (A-D)	87567.35	7462.89	60638.29	42979.51
G. Undiscounted benefit Cost Ratio (A/D)	2.57	1.13	2.55	2.19

Source: *Field Survey, 2010*

significant at 5 percent level of significance (Table 7). The regression coefficient of human labor, seed, fertilizer, irrigation, power tiller cost were 0.110, 0.350, 0.202, 0.040 and 0.215 indicating that an increase of 1 percent of human labor, seed, fertilizer, irrigation, power tiller cost, keeping other factors constant, would result in an increase in gross return by 0.110, 0.350, 0.202, 0.040 and 0.215 percent, respectively.

In the case of BR11 cultivation also, all the coefficients were significant at 5 percent level of significance. The regression coefficient of human labor, seed, fertilizer, irrigation and power tiller cost were 0.107, 0.220, 0.103, 0.040 and

Table 7 : Coefficients of Cobb-Douglas type revenue function

Explanatory variable	Estimated Coefficient			
	Rangpur		Mymensingh	
	BRRI dhan51	BR11	BRRI dhan51	BR11
Constant	3.285	1.480	3.835	1.440
	(0.621)	(0.724)	(0.353)	(0.288)
Human labor cost (X_1)	0.110**	0.107**	-0.077	0.662*
	(0.052)	(0.043)	(0.081)	(0.323)
Seed cost (X_2)	0.350**	0.220**	0.117**	1.139*
	(0.150)	(0.086)	(0.034)	(0.512)
Fertilizer cost (X_3)	0.202**	0.103**	0.009	-0.298
	(0.080)	(0.047)	(0.133)	(0.354)
Irrigation cost (X_4)	0.040**	0.028**	0.504*	-0.470*
	(0.012)	(0.013)	(0.212)	(0.222)
Power tiller cost (X_5)	0.215**	0.173**	0.485**	0.069
	(0.098)	(0.080)	(0.154)	(0.081)
R^2	0.75	0.65	0.74	0.51
Adjusted R^2	0.65	0.50	0.65	0.50
F-value	6.961	4.472	5.86	3.71
Returns to scale	0.92	0.63	1.04	1.10

Source: *Field Survey, 2010* *Note: Figures in the parentheses indicate standard error*

* *Significant at 1 percent level*

** *Significant at 5 percent level*

0.173 indicating that an increase of 1 percent human labor, seed, fertilizer, irrigation and power tiller cost, keeping other factors constant would result in an increase in gross return by 0.107, 0.220, 0.103, 0.040 and 0.173 percent, respectively.

At Mymensingh, on the other hand, all the coefficients of the explanatory variables in Cobb-Douglas type revenue function were not statistically significant at 5 percent level for BRRI dhan51 cultivation. Only the coefficients of seed cost, irrigation cost and power tiller cost were significant. In the case of BR11 production at Mymensingh, the coefficients of human labour cost, seed cost and irrigation cost were significant.

It can be concluded from the above findings that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive

and significant at 5 percent level of significance at Rangpur. The results indicated rational use of inputs for BRRI dhan51 cultivation in Rangpur. However, at Mymensingh, only the coefficients of seed cost, irrigation cost and power tiller cost were significant at 5 percent level of significance and the rest were non-significant. This indicates rational use these inputs.

Adoption patterns and tracking varietal adoption scenario of BRRI Dhan51

Factors Affecting Adoption of BRRI dhan51

In the socioeconomic profile chapter, it was observed that BRRI dhan51 cultivating farmers were more educated than BR11 cultivating farmers. So, education can be one of the factors influencing farmer's decision of adopting BRRI dhan51. Some other factors that may influence the adoption of BRRI dhan51, as gathered from interviews of the farmers, are discussed below.

Resistance to Submergence

BRRI Dhan51 can survive up to 10 to 14 days of complete submergence at vegetative stage. Its production may still be 4 to 4.5 tons per hectare despite the submergence, while BR11 or other competing aman varieties can be completely destroyed due to such submergence. All the farmers interviewed in Mymensingh and 96.67 percent farmers interviewed in Rangpur identified this reason to be the main factor for cultivating BRRI dhan51.

Higher Yield

All the farmers under this study at both the locations identified high yield to be one of the important reasons for cultivating BRRI dhan51. As mentioned earlier, the normal yield for BRRI dhan51 is 5 to 5.5 tonnes per hectare, and when submerged for 10-14 days, the yield is still 4 to 4.5 tonnes per hectare. This is quite high for a HYV of aman in Bangladesh. So the yield is one of the factors responsible for adopting BRRI dhan51 by the farmers.

Less Fertilizer and Insecticides

BRRI dhan51 requires less fertilizer and insecticides compared to other aman varieties. So the cost of production is lower. All the farmers under this study have identified this as a reason for adopting BRRI dhan51.

Good Taste

The rice cooked from BRRI dhan51 tastes delicious. Hundred percent of farmers in Mymensingh and 96.67 percent of farmers in Rangpur have identified this to be another factor for cultivating BRRI dhan51.

Tracking varietal adoption scenario of BRRI Dhan51

To examine the varietals tracking system of BRRI dhan51 and BR11 growing farmers, the varietals tracking system of the sample farmers was divided into four categories. These are (i) (0 - 1) km (ii) (1.5- 2.5) km (iii) (3- 4.5) km and (iv) 5 km and above.

Table 8 shows that in the two study areas 51.67 percent BRRI dhan51 rice producers got their seed from a distance of less than a kilometer from their house. About 28.33 percent farmers got seed from a distance of 5 kilometer and above.

Table 8 : Tracking varietal adoption scenario of BRRI dhan51 and BR11

Distance	Rangpur		Mymensingh		Both districts combined	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
	%	%	%	%	%	%
(0 - 1) km	6.67	16.67	96.67	0	51.67	8.33
(1.5- 2.5) km	16.67	23.33	0	100	8.33	61.67
(3- 4.5) km	23.33	50	0	0	11.67	25
5 km and above	53.33	10	3.33	0	28.33	5
Total	100	100	100	100	100	100

Source: *Field survey, 2010*

The rest of the BRRI dhan51 cultivators got their seed between 1.5 to 4.5 kilometers of distance from their house. On the other hand, vast majority of BR11 growing farmers (61.67 percent) got their seed from a distance of 1.5 to 2.5 kilometers, whereas 8.33, 25 and 5 percent of the BR11 farmers got their seeds from distances of 0-1 kilometer, 3-4.5 kilometer and 5 km and above, respectively. The results suggest that although adoption of BRRI dhan51 was more concentrated to sources of seed, farmers from distant places were also interested to grow BRRI dhan51 in their land. So they collected seed from long

distances when necessary. It suggests that BRRI dhan51 has the potential to spread rapidly in the regions under this study.

However, by looking at the combined figure for the two regions, the specific scenario for each region may not be understood. So, it is essential to look into the data for each region separately, which also available in table 4.6. In Rangpur, the table shows that 53.33 percent BRRI dhan51 rice producers got their seed from a distance of 5 km and above from their house. About 23 percent farmers got seed from a distance of (3- 4.5) km, 16.67 percent got seed from distances of (1.5- 2.5) km, and 6.67 percent got seed from distances of (0 - 1) km. On the other hand, about a half of BR11 growing farmers got their seed from a distance of 3 to 4.5 kilometers while 16.67, 23.33 and 10 percent of the BR11 farmers got their seeds from distances of 0-1 kilometer, 1.5-2.5 kilometer and 5 kilometer and above, respectively. Farmers are very much interested to receive this BRRI dhan51 seed to grow in their land. They collected seed from long distances and with very high price. So it is clear that BRRI dhan51 has the potential to spread rapidly in this study region.

In the case of Mymensingh, Table 7 shows that in the study area 96.67 percent BRRI dhan51 rice producers got their seed from a distance of less than a kilometer from their house and only 3.33 percent got from a distance of 5 kilometer or above. On the other hand all the BR11 growing farmers got their seed from a distance of 1.5 to 2.5 kilometers. The results indicate that farmers under study in Mymensingh had been using seed from sources close to their home.

5. Conclusions

Flood is the main problem for aman rice cultivation, which usually occur during the monsoon season in Bangladesh. Many parts of the country submerge under water after aman is transplanted, destroying the standing crops. BRRI dhan51 is a rice variety which can withstand submergence for 10 to 14 days and still produce an yield of 4 to 4.5 tons per hectare. This study was undertaken to judge the profitability of BRRI dhan51 by comparing it with another rice variety which is cultivated during the same time at similar places and understanding the adoption scenario of BRRI dhan51. As BR11 is one of the most popular and widely cultivated aman high yielding varieties in Bangladesh, it was used as the check variety for this study.

The results observed that the yield of BRRI dhan51 is higher in Rangpur than Mymensingh but the yield of BR11 is higher in Mymensingh than Rangpur (Table 5). One of the reasons is the frequent flooding in Rangpur area. Due to having the

submergence tolerance capacity, the BRRI dhan51 yield is better than BR11 in Rangpur. On the other hand in Mymensingh, the yields of both varieties are similar.

It is found that BRRI dhan51 cultivation was more profitable than BR11 in both the study areas. At Rangpur, the net returns from cultivating BRRI dhan51 and BR11 were estimated to be Tk. 87567.35 and Tk. 7462.89, respectively. At Mymensingh, the net returns were Tk. 60638.29 and Tk. 42979.51, respectively, for BRRI dhan51 and BR11. The BCR for BRRI dhan51 was 2.57 as compared to 1.13 for BR11 at Rangpur and the BCR for BRRI dhan51 was 2.55 as compared to 2.19 for BR11 at Mymensingh.

The profitability analysis of BRRI dhan51 cultivation through Cobb-Douglas type revenue function showed that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive and significant at 5 percent level of significance at Rangpur. The results indicated rational use of inputs for BRRI dhan51 cultivation in Rangpur. However, at Mymensingh, only the coefficients of seed cost, irrigation cost and power tiller cost were significant at 5 percent level of significance and the rest were insignificant. This indicates that in Mymensingh, the farmers have more scope to use inputs efficiently.

The study also revealed that resistance to submergence, high yield, good taste and requirement of less fertilizers were the main reasons for farmers adopting BRRI dhan51 at both the locations. The analysis of tracking varietal adoption scenario of BRRI dhan51 suggests that although adoption of the variety was more concentrated to sources of seed, farmers from distant places were also interested to grow it in their land. So they collected seed from long distance. It implies that BRRI dhan51 has the potential to spread rapidly in the regions under study. So, it was observed that apart from being a submergence tolerant variety, BRRI dhan51 was also profitable as compared to BR11. Farmers can greatly benefit by cultivating the variety during the aman season.

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