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ADOPTION AND PROFITABILITY OF Binadhan-16 IN SOME SELECTED AREAS OF BANGLADESH

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Abstract

The study was conducted in three Binadhan-16 growing areas of Bangladesh, namely Mymensingh, Netrokona and Rangpur districts to find out the determinants of adoption of Binadhan-16 rice variety at the farm level and to estimate the costs and return of Binadhan-16 cultivation in the study areas. This study was based on primary data which were collected from 180 farmers, 60 from each district where 30 was adopter and 30 was non-adopter of Binadhan-16 growers through face to face interview with the help of a pre-designed interview schedule. The result of logit regression model showed that farm size, yield, seed, training and extension contact had positive significant effect; and education, cultivation duration were found as negatively significant variables in explaining the variation in Binadhan-16 adoption. The study also found that total variable cost of Binadhan-16 cultivation was Tk. 44346 per hectare.The average net return per hectare was Tk. 76698. The average Benefit Cost Ratio (BCR) was 2.16. Regarding major problems of the variety cultivation, 15% mentioned about high labour cost which ranked top followed by quality seed in timely manner (14%). More emphasis should be given on farm size, seed, yield, and training programme for the expansion of the variety.

Key words: Binadhan-16, Profitability, Adoption, Determinants

Introduction

Rice is the greatest well-liked staple food and a vital source of energy, minerals, vitamins, fibre, and other biomolecules (Sen *et al.*, 2020). Rice is the staple food of about 170 million people of Bangladesh (Roy *et al.*, 2024). It provides nearly 45% of employment (BBS, 2024), about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country (Rayhan *et al.*, 2023). Currently, a small number of cereal crops such as rice, maize, and wheat that have undergone extensive breeding for high yields dominate cereal production worldwide. Bangladesh has three different cropping seasons (Boro, Aus, and Aman) and rice is the single most important crop grown in all these seasons, covering around 77 percent of the total cropped area (Huq *et al.*, 2019). In Bangladesh, Aus, Aman, and Boro- three rice crops cultivation are possible in the same land in a year since soils are fertile, the rain-fed or irrigated flood plain land, fertilizer, and other inputs are available (Anwar *et al* 2019; Mainuddin *et al.*, 2021). Aman is the country's second main rice crop in terms of output volume. Among the three concurrent cropping seasons: Aus, Aman, and Boro of Bangladesh, Aman rice has been cultivated in 5,75,0775 ha of land and the total production of the season was 16,65,6263 metric tons approximately

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(BBS, 2024). Additionally, Aman season rice straw is very essential to fuel and cattle feed for farm households (Kabir *et al.,* 2019). But the country is most vulnerable to climate change among the world. Global rice production is predictable to face more challenges in the near future, and Bangladesh is estimate to be exposed to more of those complex situations (Khatun *et al.,* 2021). Because of quick population increase as well as urbanization, the cultivated land is gradually declining demanding improved output simply to keep pace with the population growth. This is possible only by doubling productivity per unit area and by expanding MV's rice adoption and cultivation**.** A number of technologies have been identified as potential for increasing rice yield including high-yielding rice varieties, efficient agronomic management techniques, enhancing nutrient and water availability and controlling weeds (Hazel, 2010, Nhamo *et. al.* 2014). Accordingly, Bangladesh Institute of Nuclear Agriculture, BINA invented Binadhan-16 which is high yielding *aman* rice variety and short duration (life cycle 100-105 days) with other significant technology. As it is early maturing as oppose to traditional variety which takes 140 days, farmer can produce more crops in the same field. The shorter growing season also offers flexibility in planting time. Farmers can regulate sowing times to align with more favorable climatic windows, thereby easing the impact of unpredictable rainfall patterns or late-season droughts. Therefore, that help farmers cope with climate change adaptation and consequently, there is a chance to increase cropping intensity by cultivating more crop in a year. Production cost of rice and market price are directly inter-related. If farmers do not get their expected profit from rice cultivation, then adoption of any particular variety becomes difficult. Thus, it becomes crucial to understand the variety adoption factor, profitability and problem in cultivation of any variety at farmers' field and Binadhan-16 is not an exceptional. Therefore, the present study was undertaken to fulfill the following objectives:

i. to find out the determinants of adoption of Binadhan-16 rice variety at farm level;
ii. to estimate the costs and return of Binadhan-16 cultivation in the study areas; and
iii. to identify problems of the Binadhan-16 cultivation.

Materials and Methods

Selection of the study area and sample size

The study was conducted in three Binadhan-16 growing areas of Bangladesh, namely Mymensingh, Netrokona and Rangpur district. Therefore, Valuka from Mymensingh, Purbadhala from Netrokona and Sadar from Ranpur were selected purposively considering intensity of Binadhan-16 cultivated farmers (Fig. 1).

Fig. 1. Study areas.

Source https://oldweb.lged.gov.bd/UploadedDocument/GeoCoverageImage/982.pdf

A total of one hundred and eighty (180) *Aman* rice growers were taken to conduct present study. A list was prepare with the help of Department of Agricultural Extension (DAE) personnel and other scientist related with extension of Binadhan-16 to the farmers.

Collection of Data

From each of the selected district 60 farmers were questioned with predesigned interview schedule. Therefore, 30 adopter and 30 non-adopter were taken from each of the district randomly. Field level primary data were collected by the researcher with the help of trained enumerators for appropriateness of data.

Analytical techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The logit regression model was used to determine the factors

affecting the adoption of the variety. The logit regression model is one of the binary choice regression model in which a dichotomous regression variable is considered as the dependent variable. When the dependent variable is binary, the linear probability model (LPM), logit and probit can be used (Ramanathan 1998; Greene 2000). Logit model have been widely used in order to explore the factors affecting farmers' decision in adoption studies (Jarvis 1981; Feder and O'Mara 1982; Adesina et al. 2000; and Vandeveer 2001). The general logistic model expresses a qualitative dependent variable as a function of several independent variables, both qualitative and quantitative. The implicit form of the model was as follows:

$$Zi = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + U_i$$

In order to obtain the Zi there need a dichotomous response variable, if the dependent variable is 1 then the farmer is adopter of the variety otherwise zero.

The independent variables were captured as:

X_1 =Age of the respondent (Year)
X_2 = Education (Year of schooling)
X_3 = Farmers experience in farming (years)
X_4 = Farm size (hectare)
X_5 = Availability of seed (Kg)
X_6 =Annual income (BDT)
X_7 = Yield (Kg)
X_8 = Duration of cultivation (Days)
X_9 = Training
X_{10} = Extension contact

Measurement of dependent and explanatory variables are mentioned in Table 1

Table1. Measurement of dependent and explanatory variables

Variable	Type	Measurement
Dependent variable	Dummy	1 if farmer has adopted, otherwise 0
Explanatory Variable		
X_1=Age	Continuous	Age of the household head (years)
X_2= Education	Continuous	Formal education of the respondent (years of schooling)
X_3= Experience in farming	Continuous	Farming experiences of the respondents (years)
X_4= Farm size	Continuous	Amount of land under Binadhan-16 cultivation (ha)
X_5= Seed	Continuous	Seed used by farmers (Kg)
X_6= Annual income	Continuous	Amount of money earned by the family members in a year ('000 BDT)
X_7= Yield	Continuous	Yield obtained by farmers in kg
X_8= Duration (Days)	Continuous	No of days required for harvest
X_9= Training	Dummy	if received=1; otherwise=0
X_{10}= Extension Contact	Dummy	1 indicates having extension contact and 0 otherwise

Financial profitability of Binadhan-16 cultivation

Profitability is a major criterion to make decision for producing any crop at farm level. It has been measured based on net return, gross margin and ratio of return to total cost. Financial profitability has been calculated using the farm survey data of Binadhan-16.

Profitability analysis of Binadhan-16 has been determined on the basis of net return analysis. To determine the net returns from Binadhan-16 production, gross costs (variable and fixed cost) were deducted from gross returns. For this purpose, the following equation was used (Dillon and Hardaker, 1993).

The equation has been applied for each of the selected farmers:

$$\pi = Pm^* Ym + Pb^* Yb - \Sigma(Pxi * Xi) - TFC$$

Where, π = Net return
Pm = Price of main product per units
Ym = Total quantity of main product
P_b = Price of by-product per unit
Y_b = Quantity of by-product
Px_i = Price of i^{th} input per unit used for rice production
X_i = Quantity of the i^{th} input used for rice production
TFC = Total fixed cost
i = 1, 2, 3.....n (number of input)

The estimation of Interest on operating capital (IOC) was as follows:

Interest on OC = AI × i × t

Where, AI = (Total investment)/2;
i = Rate of interest per annum (%); and
t = Period of Binadhan-16 production (in months).

Results and Discussion

Factors affecting the adoption of the variety

An important purpose of this study was to explore the important factors that influence farmers' decisions to adopt Binadhan-16. Ten explanatory variables were performed in logit regression analysis in this study (Table 2). The result of test of multi-collinearity assures that such problem does not exist. The outcomes of the model reveals that the expected effect of age variable on Binadhan-16 has a negative coefficient but it was insignificant. The expected effect of Education on Binadhan-16 has a negative coefficient which was 0.432 and it was significant. One unit increase in education will decrease the log odds ratio of adopting the variety by 0.649. Another study revealed that education had no significant influence on adoption of crop (Gakii, 2024). According to Mawuli (2016), education has a higher attitude on adoption of new ideas in the sense that farmers have more capacity to adopt information than uneducated farmers. Experience of farming has a negative coefficient which was 0.002 but it was not significant. Similar result was found by

Chichongue *et al.*, 2020 and reveal that farmers with over a decade of experience in farming could be hesitant to embrace new technologies. Farm size has a positive coefficient which was 0.003 and it was significant. One unit increase in the size will increase the log odds ratio of adopting the variety by 1.003. The expected effect of seed used on Binadhan-16 has a positive coefficient which is 0.117 and it was significant. One unit increase in the seed will increase the log odds ratio of adopting the variety by 0.889. The expected effect of the variable annual income has a positive coefficient but it was insignificant. The coefficient of yield of farmer was 0.001 and it was significant at 5% probability level. The estimated value means that if one unit increase of the variable will increase the log odds ratio of adopting the variety by 1.001. Table 2 indicates that the coefficient of duration of the variety was -0.023 and it was significant at 10% probability level. One unit increase of duration of the variety will decrease the log odds ratio of adopting the variety by 0.978 while holding all other

Table 2. Estimates of the logistic regression of determinants of adopt Binadhan-16 of farm households

Variable	Co-efficient (β)	Standard Error (S.E.)	Level of significance (Sig.)	Exponential of coefficient or odds ratio Exp(β)
Age (X_1)	-0.027	0.026	0.294	0.973
Education (X_2)	-0.432***	0.102	0.000	0.649
Experience (X_3)	-0.002	0.026	0.935	0.998
Farm size (X_4)	0.003**	0.001	0.045	1.003
Seed (X_5)	0.117**	0.055	0.033	0.889
Annual income (X_6)	0.001	0.002	0.510	1.001
Yield (X_7)	0.001**	0.000	0.034	1.001
Duration (X_8)	-0.023*	0.017	0.101	0.978
Training (X_9)	0.821**	0.407	0.043	2.273
Extension Contact (X_{10})	0.416**	0.202	0.039	1.515

***,** **, and *** indicate significance levels of 10%, 5%, and 1%, respectively

variables in the model constant. The coefficient of training of farmer was 0.821 and it was significant at 5% probability level. The estimated value means that if one unit increase of the variable training will increase the log odds ratio of adopting the variety by 2.273. The coefficient of extension contact was 0.416. The estimated value means that farmers' adoption is 1.515 units higher in case of having extension contact compared to other condition while holding all other variables in the model constant.

Cost of cultivation for Binadhan-16

The cost of production included all kinds of variable costs such as hired labour, land preparation, seed, manure, fertilizers, irrigation, insecticides, etc. used for the production of Binadhan-16 rice. Both cash expenses and imputed value of family supplied inputs were included in the total cost. The study revealed that total variable cost of Binadhan-16 cultivation was Tk. 44346.29 per hectare which was 66.78% of total cost of production (Table 3). The highest cost item was human labour which accounted for about 46.44% of

the total cost. Cost of land preparation was 17.84% and land use cost accounted for about 14.63% of total cost and ranked as second and third cost items, respectively. Family labour and rental value of land were considered as fixed cost of production. The family labour and land use cost were Tk. 12340.46 and Tk. 9717.15 per hectare which was accounted for about 18.58% and 14.63% of total cost, respectively (Table 3). Total cost of production included variable costs and fixed costs incurred for Binadhan-16 cultivation. On an average, the total cost of production was Tk. 66403.90 per hectare where 33.22% was fixed costs and 66.78% was variable cost.

Table 3. Cost of Binadhan-16 cultivation in different locations

Cost Component	Cost of production (Tk/hectare)				(%)
	Mymensingh	Netrokona	Rangpur	All	
(A) Variable Cost	46283	45215	41539	44346	66.78
Hired labour (Man days)	17397	21677	16417	18497	27.86
Power tiller	13981	11252	10305	11846	17.84
Seed	1717	1803	1909	1809	2.73
Fertilizers:					
Urea	2522	2498	2392	2471	3.72
TSP/DAP	3322	2467	2865	2885	4.35
MP	1791	1799	1825	1805	2.72
Gypsum	689	880	829	800	1.21
Cow dung	1849	862	1871	1527	2.30
Insecticide	1206	882	1550	1213	1.83
Irrigation	1403	697	1211	1104	1.66
IOC	401	392	360	384	0.58
(B) Fixed Cost	21649	20247	24275	22057	33.22
Family labour	11318	10424	15279	12340	18.58
Land use cost	10331	9823	8996	9717	14.63
Total Cost (A+B)	67933	65462	65815	66403	100.00

Source: Field Survey, 2021-22

Return from Binadhan-16 production

The average return from Binadhan-16 production in different locations is shown in Table 4.The highest yield was found at Rangpur (5546 kg ha^{-1}) followed by Mymensingh (5379 kg ha^{-1}) and Netrokona (5297 kg ha^{-1}). The average selling price of Binadhan-16 was Tk. 24.88 kg^{-1} where cost of production was Tk. 12.28 kg^{-1}. The highest price of Binadhan-16 was found in Mymensingh (Tk. 25.30 kg^{-1}) and the lowest found in Ranpur district (Tk. 24.40 kg^{-1}). The average gross margin was found Tk. 98756 on variable cost basis. Gross margin was the highest in Rangpur (Tk. 101558 ha^{-1}) followed by Mymensingh (Tk. 99406 ha^{-1}), and Netrokona (Tk. 95217 ha^{-1}), respectively. The average net return per hectare was Tk. 76698. The net return was the highest in Mymensingh (Tk. 77756 ha^{-1}) followed by Rangpur (Tk. 77283 ha^{-1}), and the lowest was in Netrokona (Tk. 74970 ha^{-1}), respectively. The average Benefit Cost Ratio (BCR) was 2.16. The per hectare cost of production was 12.28 in the study areas.

Table 4. Profitability of Binadhan-16 cultivation in different locations

Type	Districts			
	Mymensingh	Netrokona	Rangpur	All
Yield from Binadhan-16 (kg ha^{-1})	5379	5297	5546	5407
Price (Tk kg^{-1})	25.30	24.95	24.40	24.88
Return from Binadhan-16 (Tk. ha^{-1})	136091	132149	135319	134548
Return from straw (Tk. ha^{-1})	9599	8284	7780	8554
Total return (Tk. ha^{-1})	145690	140433	143099	143103
Total variable cost (Tk. ha^{-1})	46284	45215	41539	44346
Total Cost (Tk. ha^{-1})	67933	65462	65815	66403
Gross margin (Tk. ha^{-1})	99406	95217	101558	98756
Net return (Tk. ha^{-1})	77756	74970	77283	76698
BCR on full cost	2.14	2.15	2.17	2.16
Cost of production	12.63	12.36	11.87	12.29

Source: Field Survey, 2021-22

Problems of Binadhan-16 cultivation in the study areas

The data presented in Table 5 indicated the problems face by Binadhan-16 growing farmers which were production, labour, fertilizer, marketing and social related problem in the study areas.

Table 5. Major Problems to Binadhan-16 cultivation in the study areas

Type of problem	No. of farmers responded				%	Rank
	Mymensingh	Netrokona	Rangpur	All area		
Production related						
Lack of quality seed	5	14	12	31	14	2
Technical know how	3	4	3	10	4	7
Infestation of disease	6	5	14	25	11	3
a) Labour related						
Scarcity of labour	2	10	9	21	9	4
High price of labour	8	14	12	34	15	1
b) Fertilizer related						
High price	4	7	7	18	8	5
Adulteration	2	8	6	16	7	6
Not get at timely	2	2	11	15	7	6
Marketing Related						
Lack of adequate price	4	7	8	19	8	5
High transportation cost	4	5	9	18	8	5
Social Problem						
Destroy by bird & animal	2	5	10	17	7	6
Other*	3	2	0	5	2	8

Source: Field Survey, 2021-22

*Natural calamity, High distance of market.

The majority 15% mentioned about high price of labour and which was the top ranked followed by quality seed in timely (14%), infestation of disease (11%), scarcity of labour (9%) (Islam et al., 2023), low price of paddy and high transportation cost (8%), adulteration of fertilizer & not got timely and destroy bird and animals (7%) and the lowest response was for other (2%) i.e. natural calamity and the market distance and ranked as 8 problems among the Binadhan-16 growers. Yield loss in severe infection conditions has been estimated as 65.4% and 56.9% for blast disease in the irrigated and rainfed ecosystem (Hossain *et al.*, 2017) respectively in the farmers' field.

Conclusion

The important drivers to meet food demand and sustain rice cultivation in future are the farmers of the country. Therefore, emphasis has to be given to the rice farmers to reach out the existing technologies. The result of logit regression model shows that farm size, yield, seed, training and extension contact were found as positively significant. Education and duration of the variety were found as negatively significant variables in explaining the variation in Binadhan-16 adoption of farm households. So, for the expansion of the variety more emphasis should be given on positively significant variables. However, the average selling price of Binadhan-16 was Tk. 24.88 kg^{-1} where cost of production was Tk. 12.28 kg^{-1}. The average Benefit Cost Ratio (BCR) was 2.16. Therefore, Binadhan-16 production is profitable in the study areas. Farmer gets good yield and also large amount of substitute in Aman season. The study also identified eight production, two marketing and one social related problems of Binadhan-16 production in the those areas**.** After high price of labour, the highest problem was availability of quality seed for Binadhan-16. Furthermore, the seed of those varieties which performed a bit better in the local demonstrations was not also sufficient (Rahman *et al.,* 2020). The third problem was disease infestation 11% for the study areas. To minimize the losses caused by diseases, it would be necessary to fully utilize existing resources Kabir *et al.* (2020). Therefore, besides emphasized on statistically significant variables quality seed also be ensured by the different institute for the expansion of the variety.

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