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ECONOMIC STUDY OF Binadhan-22 PRODUCTION IN SOME SELECTED AREAS OF BANGLADESH

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Abstract

This study was conducted in four districts of Bangladesh, namely Mymensingh, Bogura, Naogaon and Rangpur to estimate the profitability and factors affecting gross return of the variety. This study was based on primary data which were collected from 200 Binadhan-22 growing farmers. In the sampled areas data were collected through pre-designed interview schedule from January-February, 2023. Tabular, descriptive statistics and Cobb-Douglas production function model were used to fulfill the objectives. It was found that Binadhan-22 production is profitable. The average net return per hectare was Tk. 28876. The net return was highest in Rangpur (Tk. 32480/ha) followed by Naogaon (Tk. 28554/ha), Mymensingh (Tk. 27331/ha) and Bogura (Tk. 27139/ha). Benefit cost ratio was estimated at 1.39 and 2.04 on full cost and variable cost basis. Cobb-Douglas production function was chosen to determine the factor affecting gross return of Binadhan-22 production. All of the factors namely, human labour cost, power tiller cost, seed cost, fertilizer cost, irrigation cost, insecticides cost were statistically significant and positive. The regression coefficients for farming experience and agricultural training under all areas had negative but significant relationship at 5% and 10% level, respectively. The regression coefficient of age was positive and significant at 10% level. Under all areas, the regression coefficients of education and farm size were positive but not significant. Farmers faced some constraints in cultivating of the variety. The first ranked constraint was lack of availability of seeds (93%). Other constraints were lack of training (61%), lack of capital (38%) and lack of technical know-how (16%). In addition to helping farmers use a better combination of inputs that will create higher productivity and return, effective extension services may also assist farmers in cultivating rice in a way that will contribute to food security and self-sufficiency.

Key words: Profitability, Factors affecting, Cobb-Douglas production function, Binadhan-22

Introduction

Agriculture contributes about 11.38% to the gross domestic product (GDP) (BBS, 2022). Although the contribution of the agriculture sector to GDP has been gradually declining in recent years, it is still playing a major role in the economy of Bangladesh. About 45.33% of the total national labor forces are employed by the agriculture sector (BBS, 2022). Where paddy production dominates by covering 11.97 million hectares of land, which is about 74.85 percent of the total cropped area and more than 65 percent of the irrigated area of the country and stands third among the rice producing countries (MoA, 2019; Rahman *et al.*, 2021).

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Rice alone constitutes 80% of the total food grains produced annually (BER, 2017). It is the main dietary staple for 164.6 million people and provides about 55% and 75% of total protein and calories in the daily human diet, respectively (BBS, 2018). Moreover, agriculture is highly vulnerable to climate change (Rahman, 2015). Bangladesh agriculture suffers from several issues, such as limited and scattered land holdings, natural hazards, increasing temperatures, irregular and unpredictable rainfall, winter shortening, rising sea levels, rice monocropping, and low profitability in rice cultivation (Mondal, *et al.*, 2012). Bangladesh is autonomous in rice (Mainuddin, *et al.*, 2015; Timsina *et al.*, 2018). Production with an average per capita consumption of 134 kg per annum, compared to the world average of 57 kg per annum (Mottaleb, *et al.*, 2016). It is the most leading crop and produces a major distribute of farmers income and employment (Sarker, *et al.*, 2012; Alam, *et al.*, 2016).

In Bangladesh, rice is grown in three different seasons; namely *Boro* (January to June), *Aus* (April to August) and *Aman* (August to December) (Bapari, *et al.*, 2016). It is grown in four ecosystems viz., irrigated rice (*Boro*), rainfed or partially irrigated (transplanted *Aus* and *Aman*), rainfed upland (direct-seeded *Aus*), and deepwater (broadcast *Aman*). Food self-sufficiency mostly depends on rice production. The total contribution of the rice production is about 70 percent of the total agricultural contribution to GDP. Thus, it is often argued that self-sufficiency in food might be attained by enhancing the overall productivity of rice (Chowdhury, 2013). Considering the food habit of the people of Bangladesh, "rice security" should also be addressed the "nutrition security". In this country, rice is not only the carbohydrate-supplying food, but also the major provider of protein, micronutrients, and health benefits. Antioxidants supplied by rice contribute to relieve oxidative stress, and preventing cancer, cardiovascular problems and complications of diabetes (Shozib, *et al.*, 2020).

Among the three rice crops, *Aman* is the most important crops in Bangladesh. Two types of *Aman* rice are grown in this country. One is called broadcast *Aman* which is sown in the month of mid March to mid April in the low lands and another is transplant *Aman*, which is planted during late June to August. At present it is the second largest crop in the country in respect of the volume of production after *Boro* rice. Binadhan-22 is a high yielding and short duration (life cycle 112-115 days) *Aman* rice variety which contributes significantly in changing farmers' income and employment generation and meets the challenges to self-sufficiency in food production. It is notable that the area coverage of *Aman* is the largest as a single crop and *Boro* remains the second in Bangladesh.

Several preceding studies on assessing about the profitability of rice production in Bangladesh (Bwala, *et al.*, 2018; Islam, *et al.*, 2017; Noonari, *et al.*, 2015; Rahman, *et al.*, 2015; Ismail, *et al.*, 2010; Tasnoova, *et al.*, 2006; Khan, 2005; Mondal, 2005 and Anik, 2003). The present study not only analyses the profitability but also identify factors affecting gross return and the farmer's major problems or constraints about rice productions. The results of the study will add knowledge to the researchers, policymakers and other interested parties who will conduct further studies on rice farming in Bangladesh. The specific objectives of the study were i) to estimate the profitability of Binadhan-22 growers; ii) to assess the factors affecting gross return of Binadhan-22 and iii) to identify the major constraints to Binadhan-22 production.

Materials and Methods

Selection of the study area, sample size and sampling technique

The study was conducted in four districts namely Mymensingh, Bogura, Naogaon and Rangpur in Bangladesh. A total of 200 Binadhan-22 farmers taking 50 farmers from each district were randomly selected with the help of Department of Agriculture Extension (DAE) personnel for interview. Data enumerator under the direct supervision of the researchers collected field level cross sectional data using pre-tested interview schedule for this study.

Method of data collection and period of study

Data for the present study were collected from sample Binadhan-22 farmers through face to face interview method using a pre-tested interview schedule. Data were collected by the researcher with the help of trained enumerators for the period of January-February, 2023.

Analytical techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The data were analyzed with the help of suitable statistical measures as frequencies, percentages, mean and standard deviation. Total cost was composed of total variable costs (TVC) and total fixed costs (TFC). The gross return (GR) was computed as total rice output multiplied by the market price of Binadhan-22. Profit or gross margin (GM) was defined as GR minus TVC, whereas the net return (NR) was defined as Gross Return (GR) minus Total Cost (TC). Finally, the Benefit Cost Ratio (BCR) was computed as Gross Return (GR) divided by Total Cost (TC). In the study, costs and return analysis were done on both cash cost and full cost basis.

Statistical Analysis

The production of Binadhan-22 is likely to be influenced by different factors, such as, seed, labor, power tiller, chemical fertilizer, irrigation etc. The following Cobb-Douglas type production function was used to estimate the parameters. The functional form of the Cobb- Douglas multiple regression equation was as follows:

$$Y = AX_1^{b1} X_2^{b2} \dots\dots\dots\dots\dots\dots X_n^{bn} e^{ui}$$

The production function was converted to logarithmic form so that it could be solved by least square method i.e.

$$\ln Y = a + b_1 \ln X_1 + \dots\dots\dots\dots\dots\dots + b_n \ln X_n + e^{ui}$$

The empirical production function was the following:

$$\ln Y = a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + b_{10} \ln X_{10} + b_{11} \ln X_{11} + b_{12} \ln X_{12} + Ui$$

Where,

Y = Yield (kg/ha);
X_1 = No. of Power tiller;
X_2 = No. of Human labor;
X_3 = Seed (kg/ha);
X_4 = Fertilizer (kg/ha);
X_5 = No. of Irrigation;
X_6 = No. of Weeding;
X_7 = Insecticides (ml/ha);
X_8 = Age (Years);
X_9 = Education (Years);
X_{10} = Farm size (Ha);
X_{11} = Experience in farming; and
X_{12} = Training on agricultural activities.

a = Constant value
$b_1 b_2$ .... b_{12} = Co-efficient of the respective variables and
U_i = Error term.

Results and Discussion

Profitability of Binadhan-22 production

The cost of Binadhan-22 production, gross return, gross margin, net return and the benefit cost ratio (BCR) for Binadhan-22 cultivation are being discussed in the following sections.

Cost of Binadhan-22 production

The cost of human labour, power tiller, seed, fertilizers, pesticides and irrigation were taken into consideration, while calculating cost of Binadhan-22 production. Beside this, interest on operating capital was also considered as the cost of Binadhan-22 production. Total cost consists of variable cost and fixed cost that covered 68.5% and 31.5% of total cost for Binadhan-22 production.

From Table 1, the average costs of Binadhan-22 cultivation were Tk. 73204 and Tk. 50125 per hectare on full cost and cash cost basis, respectively. The highest production cost was for human labour (52.6%), followed by land use (11%), power tiller (8.7%) and irrigation (6.2%). The cost of Binadhan-22 cultivation was found highest in Bogura (Tk. 74479/ha) followed by that in Naogaon (Tk. 73239/ha), Mymensingh (Tk. 72849/ha) and Rangpur (Tk. 72250/ha), respectively.

Table 1. Per hectare cost of Binadhan-22 production in different locations

Cost Component	Cost of production (Tk./hectare)				All area	% of total cost
	Rangpur	Bogura	Naogaon	Mymensingh		
A) Variable Cost	49527	51353	50186	49433	50125	68.5
Hired labour (Man days)	23660	24003	22850	23351	23466	32.1
Power tiller	6255	6476	6050	6824	6401	8.7
Seed	1106	1153	1082	1054	1099	1.5
Fertilizers:						
Urea	2384	2433	2215	2388	2355	3.2
TSP	2102	1786	1952	2082	1981	2.7
MoP	1276	1155	1187	1205	1206	1.6
Gypsum	748	850	812	886	824	1.1
Zinc	931	689	837	980	859	1.2
Cow dung	3036	4491	4216	2436	3545	4.8
Pesticides	3056	2854	2964	3075	2987	4.1
Irrigation	4155	4614	5105	4253	4532	6.2
Int. on operating capital	818	849	916	899	870	1.2
B) Fixed Cost	22723	23126	23053	23416	23080	31.5
Family labour	14501	15002	15612	14854	14992	20.5
Land use cost	8221	8124	7441	8562	8087	11.0
Total Cost (A+B)	72250	74479	73239	72849	73204	100

Source: Field survey, 2023

Return from Binadhan-22 production

The average return from Binadhan-22 production in different locations is shown in Table 2. The average yield of Binadhan-22 was 5133 kg/ha. The yield was highest in Rangpur (5259 kg/ha) followed by Bogura (5162 kg/ha), Mymensingh (5101 kg/ha) and Naogaon (5011 kg/ha). Most of the farmers in the study areas sold their paddy just after harvest. The total return from Binadhan-22 production consists of the values of Binadhan-22 and straw.

The average gross margin was found Tk. 51955/ha on variable cost basis. Gross margin was highest in Rangpur (Tk. 55202/ha) followed by Naogaon (Tk. 51607/ha), Mymensingh (Tk. 50747/ha) and Bogura (Tk. 50265/ha), respectively. The average net return per hectare was Tk. 28876. The net return was highest in Rangpur (Tk. 32480/ha) followed by Naogaon (Tk. 28554/ha), Mymensingh (Tk. 27331/ha) and Bogura (Tk. 27139/ha), respectively. Benefit cost ratio was calculated at 1.39 and 2.04 on full cost and variable cost basis implying that the Binadhan-22 cultivation at farm level was profitable.

Table 2. Profitability of Binadhan-22 cultivation in different locations

Type	Study areas				All area
	Rangpur	Bogura	Naogaon	Mymensingh	
Yield from Binadhan-22 (Kg/ha.)	5259	5162	5011	5101	5133
Return from Binadhan-22 (Tk./ha)	97292	95497	95209	94369	95592
Return from straw (Tk./ha)	7438	6121	6584	5812	6489
Total return (Tk./ha)	104729	101618	101793	100181	102080
Total variable cost (Tk./ha)	49527	51353	50186	49433	50125
Total Cost (Tk./ha)	72250	74479	73239	72849	73204
Gross margin (Tk./ha)	55202	50265	51607	50747	51955
Net return (Tk./ha)	32480	27139	28554	27331	28876
Benefit Cost Ration (BCR)					
BCR on full cost	1.45	1.36	1.39	1.38	1.39
BCR on variable cost	2.11	1.98	2.03	2.03	2.04

Source: Field survey, 2023

Factors affecting production of Binadhan-22

To determine the effects of the explanatory variables, linear and Cobb-Douglas model were initially estimated for Binadhan-22 rice production. Some of the key variables are explained below.

The contribution of specified factors affecting production of Binadhan-22 could be seen from the estimation of regression equation in Table 3.

The regression coefficients for power tiller and human labor for Binadhan-22 under all areas were positive and significant at 1% level. On the other hand, coefficients for fertilizers and weeding were found to be positively significant at 5% level and coefficient of seed, irrigation and insecticides were positively significant at 10% level under all areas.

The positive sign indicated that using more of these inputs in Binadhan-22 production could increase the yield to some extent.

The regression coefficients for farming experience and agricultural training under all areas had negative but significant relationship at 5% and 10% level, respectively. The regression coefficient of age was positive and significant at 10% level. Under all areas, the regression coefficient of education and farm size was positive but not significant.

Coefficient of multiple determinations (R^2)

The coefficient of multiple determination (R^2) tells how well the sample regression line fits the data (Gujarati, 1995). It is evident from Table 3 that the values of R^2 were 0.841, 0.891, 0.736 and 0.868 for Rangpur, Bogura, Naogaon and Mymensingh districts, respectively. This means that around 84, 89, 74 and 87 percent of the variations in gross return for Binadhan-22, respectively were explained by the independent variables included in the model. The average value of R^2 under all areas was 0.834 means that 83 percent of the variations in gross return were explained by the independent variables included in the model.

Table 3. Estimated values of regression co-efficient and related statistics of Cobb-Douglas production function for Binadhan-22 cultivation

Explanatory variables	Study areas								All area	
	Rangpur		Bogura		Naogaon		Mymensingh			
	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value
Intercept	2.311*** (0.731)	3.231	3.610*** (1.120)	4.210	4.231*** (0.810)	8.121	3.211*** (0.631)	4.130	3.121*** (1.120)	5.450
Power tiller (X_1)	0.321*** (0.011)	1.541	0.221** (0.080)	3.121	0.321*** (0.082)	2.413	0.210** (0.015)	2.242	0.280*** (0.072)	4.131
Human labor (X_2)	0.088*** (0.081)	1.720	0.310** (0.151)	2.451	0.311*** (0.090)	2.811	0.089*** (0.081)	1.620	0.224*** (0.071)	3.420
Seed (X_3)	0.710** (0.112)	5.210	0.321* (0.090)	3.511	0.241* (0.081)	3.210	0.810* (0.121)	5.310	0.181* (0.140)	2.441
Fertilizer (X_4)	0.214** (0.078)	4.211	0.331* (0.090)	2.650	0.314** (0.080)	2.810	0.224** (0.088)	4.211	0.310** (0.142)	3.520
Irrigation (X_5)	0.021* (0.211)	2.510	0.075* (0.062)	2.240	0.084* (0.071)	2.132	0.024* (0.410)	3.220	0.072* (0.440)	2.151
Weeding (X_6)	0.090** (0.081)	1.821	0.280* (0.120)	3.532	0.132** (0.091)	2.441	0.091* (0.080)	2.420	0.221** (0.071)	4.210
Insecticides (X_7)	0.220* (0.114)	3.414	0.180** (0.131)	1.711	0.164** (0.160)	1.440	0.251* (0.118)	3.414	0.320* (0.170)	3.311
Age (X_8)	0.321* (0.081)	2.521	0.221* (0.122)	3.121	0.331** (0.080)	3.621	0.321* (0.082)	2.425	0.380* (0.091)	2.731
Education (X_9)	0.061 (0.060)	2.512	0.094 (0.081)	1.811	0.145 (0.211)	1.786	0.062 (0.061)	2.217	0.097 (0.081)	2.622
Farm size (X_{10})	0.020 (0.210)	1.752	0.140 (0.081)	2.413	0.132 (0.090)	2.712	0.021 (0.280)	1.651	0.020 (0.211)	2.810
Farming experience (X_{11})	0.431** (0.121)	3.115	-0.311** (0.081)	2.711	-0.551* (0.351)	3.654	0.531* (0.220)	3.218	-0.412** (0.211)	4.711
Agricultural training (X_{12})	0.232* (0.91)	2.461	-0.142* (0.181)	2.751	-0.212** (0.080)	3.810	0.241* (0.90)	2.881	-0.125* (0.090)	3.721
Coefficient of multiple determination (R^2)	0.841		0.891		0.736		0.868		0.834	
F-value	8.852***		9.441***		8.664***		8.141***		8.774***	
Returns to scale	1.036		1.084		1.088		1.021		1.057	

Source: Field survey, 2023
Note: *** Significant at 1% level, ** Significant at 5% level and * Significant at 10% level, (Figures in the parentheses indicates the standard errors)

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F-value

The F-values of Rangpur, Bogura, Naogaon and Mymensingh districts were 8.852, 9.441, 8.664 and 8.141 which were highly significant at 1% level of probability implying that all the explanatory variables were important for explaining the variations in gross returns of the Binadhan-22 variety in the study area (Table 3). The F-values of all areas were 8.774 which was highly significant at 1% level of probability implying that all the explanatory variables was important for explaining the variations in gross returns of the Binadhan-22.

Return to Scale

The summation of the entire production coefficient indicates return to scale. The sum of elasticity coefficients were 1.036, 1.084, 1.088 and 1.021 in case of Binadhan-22 meaning increasing returns to scale (Table 3). This means that, 1 percent increase in all inputs simultaneously would result on average 1.036, 1.084, 1.088 and 1.021 percent increase in gross return of Binadhan-22. The coefficients considering all areas was 1.057 means that 1 percent increase in all inputs simultaneously would result on average 1.057 percent increase in gross return of Binadhan-22 in the study areas. This value is greater than 1 means that the farmers are operating at the region of increasing return to scale zone. More elaborate meaning is that the farmers still have the scope to allocate more inputs in their rice field as it will generate a higher return than production cost.

Major constraints to Binadhan-22 production

Binadhan-22 is a profitable rice variety in the study areas. But still, the farmers in the study areas faced some constraints to Binadhan-22 production. The first ranked constraint was unavailability of Binadhan-22 varieties seeds in all areas. Other constraints were lack of proper training (61%), lack of capital (38%) and lack of technical know-how (16%) (Table 4).

Table 4. Major constraints to Binadhan-22 production in the study areas

Sl. No.	Constraints	Percent of farmers responded					Rank
		Rangpur	Bogura	Naogaon	Mymensingh	All area	
1.	Lack of seed availability	95	98	91	88	93	1
2.	Lack of proper training	54	65	75	48	61	2
3.	Lack of capital	34	30	62	25	38	3
4.	Lack of technical know-how	12	16	25	10	16	4

Source: Field survey, 2023

Conclusion

Binadhan-22 production in the study areas is profitable. In this study, we examined the connection between inputs and the production of Binadhan-22 in order to determine how much the output depends on which inputs. All of the factors namely, human labour cost, power tiller cost, seed cost, fertilizer cost, irrigation cost and insecticides cost are very important for Binadhan-22 production. Proper guidance is a need to farmers about Binadhan-22 production management practices in the study areas.

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