Bangladesh Journal of Political Economy

Vol. 29, No. 1, June 2013, pp. 223-233
Bangladesh Economic Association
(ISSN 2227-3182)

Economics of Cereal Crops in North-western Part of Bangladesh

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Abstract *The present study is an effort to analyze the profitability of selected cereal crops in the north-western part of Bangladesh using farm level survey data. Required data were collected from four villages of north-western part of Bangladesh. A simple multistage random sampling technique was used to collect data. Cost-benefit analysis approach is also used, which enabled us to assess the profitability of cereal crops. The major findings of the study showed that growing cereal crops was profitable as net returns for paddy (Tk. 2047), wheat (Tk. 3236) and maize (Tk. 4550) per bigha were found as positive. This is supported by the benefit-cost ratios (BCR) with the value of 1.57 for paddy, 1.74 for wheat and 1.86 for maize. Both BCR and financial analysis suggest that producing maize is more profitable compared to paddy and wheat. A multiple regression analysis was also done to explore the contribution of inputs to gross return. The study found positive contribution of irrigation and seed cost to gross return from paddy, wheat and maize in the study area. On the other hand, pesticide cost has negative contribution to gross return from paddy and land preparation cost and fertilizer cost have also negative contribution to gross return from wheat. Surprisingly, all the inputs cost have positive contribution to gross return from maize. The study also found decreasing returns to scale in the case of producing cereal crops. Equi-marginal principle was used to check the efficient use of resources, which found inefficient use of resources for the production of paddy, wheat and maize.*

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1. Introduction

Bangladesh is an agriculture dependent country. The major source of livelihood of the people of Bangladesh is agriculture. It employs nearly 47.5% of labour force and contributes about one sixth of gross national product of the country. Paddy, wheat and maize are the principal cereal crops whereas *barly,* millet, *bazra, cheena* and *kaon* are minor cereal crops in Bangladesh. More than 80% cultivable land is devoted to produce cereals in the country. Among three main cereal crops rice production dominates the farming system of Bangladesh, accounting for 75% of gross cropped area whereas only 2.5%, and 1.11% land is devoted to produce wheat and maize respectively (BBS, 2011). Rice sector provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country (Bhuiyan et al, 2002). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Although Bangladesh is a cereal crop producing country, Government of Bangladesh has to import food crops almost every year. For example, the total food grain import in 2010-11 was about 5.31 million metric tons (mt) of which 1.56 million mt. was rice and 3.75 million mt. wheat (MoFDM, 2012). With the initiation of the *Green Revolution* in the early 1970s farmers became familiar with modern HYV seeds, irrigation and fertilizer technology that augmented production of major cereals enormously at the cost of various minor crops. Rahman (2010) observed that intensive rice monoculture led to displacement of land under low productive non- rice crops. But the problem is that, although *Green Revolution* had increased yield, farmers were not aware of the proper usage of that technology. As a result rice monoculture, usage of irrigation, chemical fertilizer, pesticide etc. has been increased over the years. Ultimately, it increases production cost and reduced farmers' profit margin. In addition, shrinking of agricultural land due to ever increasing demand for housing, industrialization and infrastructure development became a notable problem in agriculture. Gradually it is found in many instances that farmers are moving to maize production or other cash crop production because of lesser profit margins associated with rice farming. For example, Siddique (2013) found farmers are losing interest in cultivating *boro* due to high production cost and low market price and they are being forced to grow crops like maize.

North-western part of Bangladesh is popularly known as the granary of Bangladesh. Due to various facilities like irrigation intensity, cheap labor force, farmers' efficiency and devotion to agriculture the area grows a verity of crops. This region is still a food surplus region in Bangladesh. Cropping intensity in this

region is very high compared to other areas of the county. Like other regions of the country, north-western part has also been facing a problem of transformation of crop land into fish farming and fruits farming due to expectation of high profit margin. Thus, the decision to produce rice by farmers is getting vulnerable day by day which poses a threat to food security in Bangladesh. In many discussions it is found as quoting by the farmers that they do not want to produce paddy any more if they have opportunity to cultivate other crops. However, reports reveal that still more than 75% land in the country is devoted to rice farming. Therefore, it is required to make a comparative study of different cereal crops with the perspective of economic viability to the farmers.

The present study is an attempt to analyze the profitability of cereal crops in North- Western Bangladesh. Specifically this study concentrates on i) measuring cost and benefit involved with cereal crop production ii) determining the contribution of inputs to gross return, and iii) analyzing the economic efficiency of resource use in cereal farming.

2. Literature Review

A good number of studies have been carried out on measuring the costs and benefits of various cereal crops, like paddy, wheat, maize etc. Majumder et al (2009) studied the efficiency and productivity of *boro* rice production by owners, cash tenants and share cropper tenants. They found that efficiency and productivity of the owner and cash tenant farmers are higher than share cropper tenants. Moniruzzaman et al (2009) studied benefit cost ratio of maize production. They calculated benefit cost ratios on the basis of total cost, variable cost and cash cost for the cereal crops- rice and maize. The result found is that, maize cultivation was more profitable than rice cultivation.

Jahangir Kabir and Islam (2012) did a comparative study between wheat and rice production and found that net return from wheat is higher than that of *aman* and *boro* rice. Rahman et al (2012) studied technical efficiency of rice producers using stochastic frontier model. They found that gross return was the highest for small farms and net return was the highest for marginal farms. The lowest net return or the highest cost of production was mounted up from both the highest wage rate and highest amount of labor used in medium farms. The marginal farms experienced the highest benefit-cost ratio (BCR) followed by small and medium farms. Ali et al (2009) studied maize- rice cropping system in Bangladesh and they found hybrid maize far more profitable than *boro* (irrigated) rice, wheat, or most other competing winter season *Rabi* crops.

3. Methodology

3.1 Sample Selection

The study was conducted in four villages of North Western region of Bangladesh. These villages are chosen from two districts- Rajshahi and Thakurgaon, belonging to two divisions which constitute north-western Bangladesh. The two villages are Gholharia and Mollikpur under Paba upzila of Rajshahi district and the other two villages are Chapor and Hatpara under Pirgonj upzila of Thakurgaon district. In doing the sampling, at the first stage, two districts were chosen from two divisions of north-western Bangladesh. In the next stages, two upazilas from two districts, two unions from the two selected upazilas and two villages from each of the two unions were selected. Finally households were selected randomly from the villages. A total of 173 farmer households (taking at least 40 from each village) were selected and interviewed using structured questionnaire.

3.2 Empirical Model

3.2.1 Techniques of Cost-Benefit Analysis

The gross return of producing cereal crops was derived from the sale revenue of crops.

Thus, GR = Q×P……..….....(1)

Where, GR = Gross return
Q = Total production and
P = Per unit price of cereal crop

Again we know that gross margin is equal to gross return less total variable cost and net return is equal to gross return less total cost. Thus,

GM = GR-TVC……..….....….(2)

Where, GM = Gross margin
TVC = Total variable cost

NR = GR – TC…….…….....…..(3)

Where, NR = Net return
TC = Total cost (sum of variable cost and fixed cost)

In addition to financial or activity budget analysis, benefit cost ratio (BCR), calculated by using total variable cost (TVC) and total cost (TC), was also used to assess the profitability of producing cereal crops.

3.2.2 Cobb-Douglas Production Function

Cobb-Douglas form of production function was used to estimate the major factors affecting gross return for paddy, wheat and maize production. It is the most widely used model for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady & Dillon, 1961). It is a homogeneous function that provides a scale factor enabling one to measure the returns to scale and to interpret the elasticity coefficients with relative ease. Cobb-Douglas production function is also relatively easy to estimate because in logarithmic form it is linear and parsimonious (Beattie & Taylor, 1985). Thus, Cobb-Douglas specification provides an adequate representation of the agricultural production technology. The empirical Cobb-Douglas frontier production function model can be expressed as,

$$Y = AX_1^{b1} X_2^{b2} \ldots X_n^{bn} e^{ui} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The production function is transformed into logarithmic (double log) form, that is, log linear form so that Ordinary Least Squares (OLS) estimation method can be used to estimate the model. The log linear form of the model is;

$$\log Y = \log A + b_1 \log X_1 + b_2 \log X_2 + \ldots\ldots + b_n \log X_n + u_i \quad \ldots\ldots\ldots\ldots(5)$$

In different studies various factors and factor costs were found to have significant contribution to gross return from cereal crops cultivation. These are land preparation cost, labor cost, seed cost, fertilizer costs, pesticide costs, irrigation cost etc. Thus, the specification of the above Cobb- Douglas function in logarithmic form is as follows:

$$\log Y = \log A + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + u_i \quad \ldots\ldots\ldots(6)$$

Where, Y = Gross return from Paddy/ Wheat/ Maize (BDT/ bigha)

X_1 = Land preparation cost (BDT/ bigha)
X_2 = Labor cost (BDT/ bigha)
X_3 = Seed cost (BDT/ bigha)
X_4 = Fertilizer cost (BDT/ bigha)
X_5 = Pesticide cost (BDT/ bigha)
X_6 = Irrigation cost (BDT/ bigha)

b_1, b_2, b_3, b_4, b_5, and b_6 are regression coefficients and u_i is the stochastic disturbance term which is independently and identically distributed random errors with zero mean and constant variance, that is, .

3.3.3 Equi-Marginal Principle

The resource use efficiency of the farmers was tested by applying equi-marginal principle of neo-classical theory (Majumder et al, 2009). Neo-classical theory states that in order to ensure maximum profit and efficient use of resources, it must be utilized at the level where their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition. It is calculated by using the basic economics formula as MVP/ MFC= 1. That is, efficiency of the inputs was measured by the ratio of marginal value product (MVP) to the marginal factor cost (MFC) of each variable input. When MVPs are equal to MFCs then the profit is maximized. If it is greater than one, the resource is under used and if it is less than one, the resource is over used. As the MFC is the price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder et al, 2009). MVP is calculated by the following formula;

$$MVPx_i = bi * \overline{Y}_{GM} / \overline{X}_{iGM} \quad \text{.....(7)}$$

Where, b_i is the regression coefficient, Geometric Mean of Gross Return, Geometric Mean of variable inputs.

To estimate the regression, SPSS version 17.0 was used. Multicollinearity was checked using Variance Inflation factor (VIF), the calculated values were less than 5 (the cutoff point) for all the predictor which indicates that Multicollinearity was not a serious problem in the model. Durbin Watson test was also carried out for checking auto correlation. Independent sample *t* test was carried on to find out the difference between the mean value of the selected socio- economic and demographic characters of the farm and farmers' of the study areas.

4. Result and Discussion

4.1 Socio-economic and Farm Level Characteristics of the Farmers

The socio-economic and farm level characteristics are presented in Table 1. From the table it is found that average age of the sample farmers is 42.38 years in the study area which is statistically significant considering regional mean difference in the age of the farmers of Rajshahi and Thakurgaon districts. Average age of the farmers of Rajshahi is smaller than that of Thakurgaon. Similar picture is seen in the case of average land ownership, farm size and annual family income. Another notable characteristic of the farm in north-western part of Bangladesh is irrigation intensity. 84.73% cultivable land has under irrigation facility which is much

higher than that of the national average. The reason behind higher land under irrigation might be the irrigation facility of Barind Multipurpose Development Authority (BMDA). In recent years BMDA has installed more than thousand deep tube-wells in north-western region. In addition, quite a large number of shallow tube-wells have been installed by private initiatives for irrigation purpose. Average education level and family size of the farmers are found as 5.05 years of schooling and 5.28 persons, respectively, and there is no significant difference between the considered districts.

4.2 Results of Profitability Analysis of Cereal Crops (bigha)

Table 2 shows the results of cost-benefit analysis of three main cereal crops in north-western part of Bangladesh. Table 2 reveals that gross margin and net margin for paddy, wheat and maize is positive which indicates that producing these three cereal crops are profitable in the study area. The benefit-cost ratios (BCR) of paddy, wheat and maize are also greater than unity which also indicates that producing major cereal crops are profitable. From Table 2 it is clear that gross margin, net margin and BCR are higher for maize production than wheat and paddy. The reason might be the high demand for maize for feeding fish and poultry which ensure high price of maize and another reason might be the high rate of yield of maize.

Table 1 : Socio-economic Characteristics of the Farmers

Socio economic character	Rajshahi	Thakurgaon	All	t-value
Age of the respondent	39.93	45.06	42.38	-3.20***
Education of the respondent	5.05	5.04	5.05	0.04
Experience of the respondent	23.92	23.10	23.53	0.51
Family size	5.42	5.13	5.28	0.98
Land ownership	183.19	268.19	223.74	2.09**
Farm size	206.26	340.29	269.88	-3.21***
Annual family income	173204	227560	199132	-4.51***
Irrigation coverage	85.27%	84.13%	84.73%	0.97

Source: *Authors' Own Calculation.*

Note: *** Significant at 1% level, ** Significant at 5 % level, * Significant at 10 % level

4.3 Discussion of Regression Results

The regression results are shown in Table 3. The estimation results reveal that pesticide cost is statistically significant and negatively related to gross return of paddy indicating that 1% increase in pesticide cost would decrease gross return of paddy by 0.12%. Irrigation cost is statistically significant and has positive relation

to gross return of paddy. This result means that 1% increases in irrigation cost would increase gross return from paddy by 0.09%. The other inputs cost like land preparation cost, labor cost, seed cost, fertilizer cost also have positive effect on gross return form paddy but they are statistically insignificant.

Table 2 : Results of Profitability Analysis of Cereal Crops (bigha)

Particular	Paddy	Wheat	Maize
A. Yield (Mound)	19.31	14.31	26.67
B. Gross Return (Tk.)	13050	13240	14714
C. Total Variable Cost (Tk.)	8321	7596	7898
D. Fixed cost (Tk.)	2682	2408	2266
E. Total Cost (Tk.)	11003	10004	10164
F. Gross Margin (B-C)	4729	5644	6816
G. Net Margin (B-E)	2047	3236	4550
H. BCR Over TVC (B/C)	1.57	1.74	1.86
I. BCR Over TC (B/E)	1.19	1.32	1.45

Source: *field survey, 2013*
Note: ***Significant at 1% level, ** Significant at 5 % level, * Significant at 10 % level

Land preparation cost has negative influence on gross return of wheat. This result indicates that 1% increase in land preparation cost will decrease gross return by 0.19 %. Again from the result it is observed that 1% increase in labor cost and seed cost will increase gross return from wheat by 0.15% and 0.18%, respectively. Fertilizer cost has negative and irrigation cost has positive change on the gross return from wheat. From the estimated result it also appears that the gross return from maize is positively influenced by pesticide cost and it is highly significant. Other input cost like land preparation cost, labor cost seed and seedling cost, fertilizer cost and irrigation cost also influence the gross return from maize positively but these are not statistically significant.

4.4 Results of Resources Use Efficiency

Table 4 presents the results of resources use efficiency in paddy, wheat and maize production. Power tiller/tractor, labor, seed, fertilizer, pesticide and irrigation are the main resources of paddy, wheat and maize production. We tested all the inputs' efficiency by Marshalian equi-marginal principle by the ratio of MVCs and MFCs of the inputs.

Table 3 : Regression Results

Explanatory variables	Paddy		Wheat		Maize	
	Coeffi cient	t-value	Coeffi cient	t-value	Coefficient	t-value
Intercept	3.75***	6.68	3.63**	6.66	2.73***	3.87
Land preparation cost (X_1)	0.04	.59	-.19**	-2.00	.05	.99
Labor cost (X_2)	0.03	.05	.15*	1.68	.01	.03
Seed/seedlin g cost (X_3)	0.05	.51	.18*	1.91	.03	.36
Fertilizer cost (X_4)	0.05	.68	-.04	-.75	.01	.20
Pesticide cost (X_5)	-0.12**	-1.95	-	-	.21***	2.77
Irrigation cost (X_6)	0.09***	3.21	0.07	1.01	.19	1.56
R^2	.21		0.11		0.17	
Adjusted R^2	.18		0.06		0.1	
F- Value	7.29***		2.3**		2.29**	
DW	1.56		1.46		1.39	
Returns to scale (? b)	0.14		.17		.50	

Source: *field survey, 2013*
Note : *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

It is evident from Table 4 that in the case of paddy production, the ratio of MVP and MFC of seed and irrigation cost is greater than one, which indicates that farmers have more scope to use these resources to increase return from paddy. On the other hand, since the ratio of MVP and MFC of land preparation cost, labor cost and fertilizer cost is less than one, farmers should limit the use of these resources to increase return from paddy production. In case of pesticide, the ratio of MVP and MFC is negative, which indicates that farmers use pesticide excessively. If we look at wheat production, it is clear that the ratio of MVP and MFC of seed and irrigation cost is greater than unity. It indicates that farmers have more scope for the use of resources to increase return. Labor use should be limited to increase return from wheat production. In addition, the ratio of MVP and MFC of land preparation and fertilizer cost indicates that farmers use the resources excessively. Now, if we turn to the gross return of maize, we see that there is more scope to use fertilizer and irrigation in maize production to increase gross return,

whereas the ratio of MVP and MFC of land preparation cost and seed cost indicates that usage of this resources should be limited to increase gross return. Labor and pesticide have been used excessively in maize production.

Table 4 : Resources Use Efficiency of the Inputs

Inputs	Paddy		Wheat		Maize	
	GM	$MVPx_i/MFCx_i$	GM	$MVPx_i/MFCx_i$	GM	$MVPx_i/MFCx_i$
Gross Return	12973	-	13156		14678	-
Land preparation cost (X_1)	1017	0.51	1041	-2.40	844	0.70
Labor cost (X_2)	3365	0.12	2901	0.68	3502	-0.13
Seed/seedling cost (X_3)	567	1.14	782	3.03	561	0.26
Fertilizer cost (X_4)	1849	0.35	2071	-0.25	1788	1.23
Pesticide cost (X_5)	508	-3.06	-		432	-0.68
Irrigation cost (X_6)	864	1.35	699	1.32	659	2.23

Source: *Authors' Own Calculation*

5. Conclusion

Cereals are the prime sources of carbohydrate. In Bangladesh cereals especially rice is the staple food for human beings. Wheat and maize are also used as food crops in Bangladesh. It is found from the study that maize and wheat are now more profitable cereal crops than paddy. Farmers are becoming reluctant to grow rice which is a great threat for food security. To ensure food security at all levels government should come forward to ensure fair price for cereal crops and take necessary steps to change the food habit of the people of Bangladesh.

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