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PROFITABILITY COMPARISON BETWEEN BORO RICE AND MAIZE PRODUCTION IN DINAJPUR DISTRICT

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ABSTRACT

The study focuses on comparing technical efficiency and profitability between Boro rice farmers and maize farmers in Dinajpur district consisting of 150 randomly collected samples which are analyzed with statistical software STATA 12.0 version. Stochastic Frontier Analysis (SFA) is used to accomplish the first objective where it is found that the maize farmers are efficient compared to boro-rice farmers. The deviation of the mean technical efficiency is estimated at 0.09. In addition maize farmers are also more profitable than boro-rice farmers estimated with a benefit Cost Ratio (BCR) of1.08 is for boro-rice and 1.26 is for maize production. The net profit for boro-rice is estimated as 10,527.60 Tk./ha whereas 28,966.40 Tk./ha for maize producers. However mean technical efficiency of boro-rice (0.44) and maize (0.53) cultivation clearly indicates that better utilization of resources will raise the efficiency and profitability for both crops production.

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INTRODUCTION

Bangladesh is a small and overpopulated country and the economy of Bangladesh is primarily dependent on agriculture which contributes about 14.23 percent to the Gross Domestic Product (BER, 2020). The major crops produced in Bangladesh are rice, wheat, maize, jute, sugarcane, potato, vegetables, etc. Among these crops boro-rice (post-monsoon rice from January to June) is widely cultivated all over the country. Farmers generally decided to allocate their land and all other resources in the production of different crops on the basis of relative financial profitability and technical efficiency of production. Last few years the cultivation of maize is increasing and is gaining importance in recent years as a promising crop aimed at boosting agricultural growth in Bangladesh (Rahman et al, 2014). Although the production of maize in Bangladesh is about 2.81 MT in 2019 (BBS, 2020) but it is very low in terms of the quantity demanded. There has an ample opportunity to increase maize cultivation area and yield for its soil condition, topography and climate in Bangladesh (Hossain et al, 2015). According to Bangladesh Agricultural Yearbook (2018), the total boro-rice yield per acre was 1,630 kg and total maize yield per acre was 3,323 kg. Maize is considered as the second important cereal crop after rice in Bangladesh (Ahmed, 2016). Scientifically proved that maize is a photo intensive and c4-cycle crop and it can be grown throughout the year (Alam et al., 2019).The cultivation of maize is profitable and technically efficient than any other crops in Bangladesh and the production of maize is considered as a profitable enterprise (Sampa, 2018). In the northern region of Bangladesh, most of the farmers used hybrid seeds for maize cultivation with an average yield of 6.27 ton/ha which is higher in Dinajpur district (6.18 ton/ha) than Panchagarh district (6.18 ton/ha) and the technical efficiency was found on average 0.84 at Dinajpur and 0.80 at Panchagarh (Hasan, 2008). An increase in the level of education, maize farming experience, extension contact as well as uses of fertilizer and improved seeds would increase the technical efficiency of maize producers in Ghana (Abawiera et al., 2016). The average level of technical efficiency of the maize farmers was very high (96.90%) and farmers age, education and training had positive effect on maize production and if farmers should be provided proper training on advanced farming and earns credit facilities, they can boost up maize production in Bangladesh (Rahaman et al., 2013). On the other hand, (Hasnain et al., 2015) studied on technical efficiency of boro rice production using data from boro rice farmers of Meherpur district in Bangladesh and found that technical efficiency of boro rice farms in Meherpur district is 89.5% and labor, fertilizer, pesticide, seed and irrigation are significant factors that affect the level of technical efficiency.

Farm size and ploughing cost are found insignificant in affecting technical efficiency of boro rice production. The poorer access to extension service, good quality seed, phosphorous fertilizer, pesticides and power supply were the main barrier to achieve potential performance of rice cultivars and expected level of returns in Bangladesh (Lucky et al., 2018). (Thamina, 2017) conducted a study to compare the profitability of boro rice and jute in Rajoirupazila of Madaripur district in Bangladesh and found that jute was more profitable than boro rice in the study area as the (BCR) of jute was 1.52 which was higher than boro rice 1.10. (Hasan et al., 2016) studied the technical efficiency of boro rice farms and determines some factors such as farm size, age, education, training and credit facility are the significant factors which are positively related to technical efficiency of boro rice production. This study was designed to compare the technical efficiency and relative profitability between boro-rice and maize cultivation in the selected areas of Dinajpur district.

MATERIALS AND METHODS

This study was conducted covering three upazilas namely Birganj, Chirirbandar and Dinajpur sadar upazila of Dinajpur district consisting of 150 sampled farmers which were randomly selected and the data were analyzed by statistical Software STATA version 12.0.

Analytical Technique

Cobb-Douglas Production Function is taken as stochastic functional form for resource use efficiency in this present study which shows a functional relationship between inputs and outputs. Considering two variable inputs for example one is labor and another is capital, then the function can be expressed as

$Y = AL^{\beta}_{1}K^{\beta}_{2}e^{v_i - u_i}$

Where Y = level of output, L and K = Labor and Capital are variable inputs, A = multiplicative constant, $\beta_1$and β_2 are the coefficient of L and K and they represent elasticity of the respective factors of production, and e = error term. By linearizing with double-log form, the function is as

$$\text{Ln } Y_i = \beta_0 + \beta_1 \text{Ln } X_{1i} + \beta_2 \text{Ln } X_{2i} + \beta_3 \text{Ln } X_{3i} + \beta_4 \text{Ln } X_{4i} + \beta_5 \text{Ln } X_{5i} + \beta_6 \text{Ln } X_{6i} + \beta_7 \text{Ln } X_{7i} + \beta_8 \text{Ln } X_{8i} + \beta_9 \text{Ln } X_{9i} + \beta_{10} \text{Ln } X_{10i} + v_i - u_i$$

Where, Ln = Natural logarithm; Y_i = Yield of the i-th farm (kg/ha); X_{1i} = Land area (Hectare); X_{2i} = Human labour used by the i-th farm (man-days/ha); X_{3i} = Seed used by the i-th farm (kg/ha); X_{4i} = Urea used by the i-th farm (kg/ha); X_{5i} = TSP used by the i-th farm (kg/ha); X_{6i} = Murate of Potash (MoP) used by the i-th farm (kg/ha); X_{7i} = Manure by the i-th farm (kg/ha); X_{8i} = Irrigation cost of the i-th farm (Tk./ha); X_{9i} = Pesticide used by the i-th farm (ml/ha); X_{10i} = Cost of tractors used (Tk./ha); $v_i - u_i$ = error term.

Technical Efficiency

Technical efficiency of a farmer can be referred to the ratio of observed output to the frontier output, given the quantity of resources employed by the farmer. Then technical inefficiency can be considered as the indication at which the yield lies below the frontier one (Awunyo*et. al.*, 2016). Thus technical efficiency is as:

$$\text{Technical Efficiency} = \text{TE} = \frac{y_i}{y_i^*}$$

Where, y_i^* = f (x_i; β) indicating the highest predicted value for the i^{th} farm and y_i is the actual output; $TE_i = Exp\,(-u_i)$; Technical inefficiency = 1-TE_i

RESULTS AND DISCUSSION

Profitability Analysis

Table1 shows variable input cost implemented to per hectare cultivation of boro-rice and maize in the study area. From both perspectives the labor cost is the highest among all the variable costs but the labor cost (Tk.29810.53/Per ha.) of maize cultivation is relatively lower compared to that (Tk.40317.11/Per ha.) of boro-rice cultivation. In case of total variable cost of both crops cultivation, boro rice cultivation costs was Tk. 86863.90 per hectare where maize cultivation wasTk.68357.13 per hectare of cultivation indicating relatively lower cost of boro-rice cultivation with the same inputs. This difference may be one of the valid reasons for farmers to shift to produce maize more.

Table 1. Variable cost of production in per hectare of Boro-rice and Maize

Items	Boro-rice	Maize
Seedling	5121.62	8688.31
Urea	3919.64	5556.42
TSP	3589.43	5256.70
MP	2470.84	3166.93
Power tiller	6853.54	5385.09
Irrigation	17486.63	4861.68
Insecticides	4458.89	3216.83
Manure	2646.20	2414.64
Labor cost	40317.11	29810.53
Total	86863.90	68357.13

Source: Authors' calculation from field survey, 2017

Profitability analysis of both crops (table 2) reveals that net profit from maize cultivation (Tk. 28966.40) per hectare with the Benefit-Cost Ratio (BCR) of 1.26 is larger compared to that of boro-rice cultivation (Tk.10527.60/ha.) with the Benefit-Cost Ratio (BCR) of 1.08 alluding clearly that the production of maize is more profitable compared to production of boro-rice in the study area. The differences also allege why farmers choose to produce maize more instead of boro-rice and the larger this difference is more influencing factor for the farmers to cultivate maize and vice versa.

Table 2. Comparative Profitability of Boro-rice and Maize production in per hectare

Items	**Boro-rice**	**Maize**
Total revenue (TR)	140956.30	139500.32
Total variable cost (TVC)	86863.90	68357.13
Total fixed cost (TFC) (Rent + IC)	43564.80	42176.80
Gross Margin (TR-TVC)	54092.40	71143.19
Net Profit TR-(TVC+TFC)	10527.60	28966.40
Benefit–Cost Ratio (BCR)	**1.08**	**1.26**

Source: Authors' calculation from field survey, 2017

Table 3. Estimation of Cobb-Douglass Stochastic frontier Production function for both Boro-Rice farmers and Maize farmers in Dinajpur district (N=150)

Variables description	**Boro Rice Farmers**		**Maize Farmers**	
	Coefficients	**Z-Statistics**	**Coefficients**	**Z-Statistics**
Constant	1.177 (1.08)	1.08	3.483 (2.49)	1.40
Land area (Hectare)	-0.048*** (0.11)	4.21	0.014 (0.058)	0.25
Human labor (Man-days)	0.062*** (0.08)	-2.77	-0.022(0.09)	-0.24
TSP (kg/ha)	-0.133* (0.13)	-1.79	0.473* (.25)	1.78
Seed (kg/ha)	0.032(0.09)	0.34	0.230(0.34)	0.68
Urea (kg/ha)	0.090** (0.13)	-2.09	-0.546(0.45)	-1.19
MoP (kg/ha)	0.019* (0.06)	1.85	0.387***(0.06)	6.19
Pesticide (ml/ha)	0.106*** (0.06)	-2.67	0.120(0.07)	1.58
Manure	0.033 (0.21)	0.16	-0.065(0.20)	-0.32
Irrigation cost(Tk./ha)	0.121* (0.06)	1.81	-0.002(0.03)	-0.06
Tractor Charge (Tk./ha)	0.175 (0.11)	1.55	-0.119*** (0.04)	-2.60
Sigma (σ_v)_v	0.516		0.477	
Sigma(σ_u)_u	0.006		0.010	
Sigma-squared(σ_s^2)	0.266		0.228	
Gamma (γ)	0.00013		0.00043	
Lambda	0.011		0.026	
Wald chi^2	23.52***		142.23***	
Log likelihood	-75.796		-68.076	

Note: *, ** and *** refers to 10%, 5% and 1% significance level, respectively.
Figures in the parentheses indicate Standard Error.

Estimated Results of Production Function and Technical Efficiency

The estimation of technical efficiencies for both crops can be obtained from combining both Cobb-Douglas production functions. In the words of Piesse and Thirtle (2000), the value of sigma square varies from 0 to 1. If the value of estimated parameter is equal to zero that means non-existence of technical inefficiencies in our study while a value of 1 or closer to 1 implies more appropriate model fitted as well as the value also shows the goodness of fit. The estimated value of sigma square is 0.266 ($P<0.01$) indicating a 26.6% residual mutation (table 3). Having Wald Chi-square at 1% level of significance, we can reject the null hypothesis about the purity of inefficiency for both crop producers. For boro rice cultivation, positively correlated coefficients are found for seed (0.032),urea (0.090), MoP (0.019),manure (0.033),irrigation cost (0.121),tractor Charge (0.175) from which human labor ($P<0.01$), pesticides ($P<0.01$), urea ($P<0.05$), Mop ($P<0.10$) and irrigation charge ($P<0.10$) have significant impact except manure (Table 3) whereas a significant ($P<0.10$) correlated coefficient is found for TSP(-0.133). On the contrary, TSP and MoP are found to have significant and positively correlated with coefficients as 0.417 ($P<0.10$) and 0.387 ($P<0.01$), respectively for maize producers (Table 3) and all the rest have not significant correlation with the production of maize.

By accomplishing our objective to compare technical efficiency between boro rice farmers and maize farmers, it is found that the mean technical efficiency of maize farmers have higher than that of boro-rice farmers in the study area identified by the deviation of 0.09. This clearly notifies that the maize farmers are more technically efficient compared to that of boro-rice farmers in Dinajpur district.

Table 4. Technical Efficiency of Boro-rice and Maize farmers

Type of Farmers	Minimum	Maximum	Mean	Standard Deviation
Boro-rice	0.02	0.90	0.44	0.16
Maize	0.05	0.99	0.53	0.19

Source: Authors' own computation from field survey 2017

CONCLUSIONS

It can be concluded that the sampled maize producers in Dinajpur district are more efficient and making profit compared to that of boro rice producers in the study areas. Along with these results environmental and soil fertility advantages, the farmers of this district are shifted more on the production of the maize rather than boro-rice. It has also been seen that the per hectare production of boro rice is more expensive compared to maize. The technical efficiencies of both crops production indicate that it can be raised more by proper utilization of resources and better management of technical knowledge of the farmers.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this paper.

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