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ESTIMATION OF ECONOMIC EFFICIENCY OF *BORO* RICE PRODUCTION: A STOCHASTIC FRONTIER APPROACH

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ABSTRACT: Rice is the dominant food crop in Bangladesh agriculture. To achieve self-sufficiency of food grain production in Bangladesh, it is very important to increase rice production. Production may be increased by improving efficiency of the farmers. Economic efficiency is a state where every input is used optimally so that each farmer can minimize cost of production and inefficiencies. Thus, the main objective of the present study is to estimate economic efficiency and factors affecting economic inefficiency of rice production in Bangladesh using data of *Boro*rice farmers. Required data were collected from 112 rice producing farmers' from*Jhenaidah* district using multistage random sampling procedure. The present study employed translog stochastic cost frontier approach to estimate the economic efficiency. Inefficiency model also used to determine the factors affecting on economic inefficiency. Empirical result of this study showed that mean economic efficiency of was 59.34% and labor cost, irrigation cost, fertilizer cost and output were important variables to explain economic efficiency. Farm size, age, experience, training and extension service were statistically significant to explain economic inefficiency. This study suggested that efficiency level can be increased by improving the training and extension service of the farmers.

KEYWORDS: Self-sufficiency, translog stochastic cost frontier approach, economic efficiency, Bangladesh.

1. INTRODUCTION

Agriculture has played a major role in the development of Bangladesh and continues to be crucial for the economic growth of the country [20]. Although the direct contribution of agriculture sector to economic growth has slightly decreased over time, its indirect contribution to the overall economic development is significant [15]. It provides raw material to the agro based industries, helps in capital formation as well as provides food for the people. It not only provides food for the people but also creates the largest source of employment. Because, 47.5% of the labor forces of the country are engaged in agriculture sector [6]; [10]. In fiscal year 2013-14, up to July-February, Bangladesh earned US$ 899 million by exporting agricultural product which was 4.53% of total export earnings [6]. In addition to the exports of main agricultural commodities such as raw jute, jute goods, tea, frozen foods, the government has taken steps to increase exports of non-traditional agricultural commodities [5]. So, agricultural sector is regarded as the lifeline of Bangladesh economy.

Rice, wheat, jute, pulses, vegetables, oil seeds, sugarcane and potato are the major crops grown in Bangladesh. Among them, rice is the most important food grain of Bangladesh agriculture and about whole population of the country depends on it for calories [14].Besides, it accounts for 94% of the cereal

consumption by the people, supplies 68% of the protein in the national diet, accounts for approximately 78% of the value of agricultural output and 30% of consumer spending [2]; [13];[10]. Again, about 82% of total agricultural production comes in the form of rice [4]. It is grown in the three crop seasons namely Aus, Aman and Boro. According to BBS final estimate, the volume of food grain production in fiscal year 2009-10 is about 341.13 lakh metric ton in which Aus is 17.09 lakh metric tons, Aman is 122.07 lakh metric ton and Boro is 183.41 lakh metric ton. So, it is obviously said that, Boro is the major part of rice production in Bangladesh [7].For the growing population, more food grain production must be needed [21]. For this reason, there will be a more pressure on existing cultivable land [15]. In this situation, agricultural intensification particularly the adoption of modern agricultural technology (e.g., chemical fertilizers, pesticides, etc.) must be essential [12]. This is the great issue to various researchers. They have said that as a result of more adoption of modern agricultural technology economic efficiency of farmers is decreasing.

The measurement of efficiency in rice production is an important issue to make effective management decision of resource allocation and formulate different kinds of policies for the improvement of rice production [15]. [9] Introduced the efficiency measurement by distinguishing three types of efficiency. These are technical efficiency, allocate efficiency and economic efficiency. Technical efficiency means the ability of a firm to obtain maximum output from a given set of inputs whereas allocate efficiency is defined as the ability of a firm to use optimal factor combinations, given their respective prices and the production technology [9]. [9] Showed that economic efficiency is defined as the product of technical efficiency and allocate efficiency which reflects the ability of a farm to produce a well-specified output at the minimum cost. By this definition, it can be said that, economically efficient farm should be both technically and allocatively efficient. However, the main objective of this paper is to estimate economic efficiency and determine the factors affecting on economic inefficiency of *Boro* rice production in *Jhenaidah* district of Bangladesh.

2. LITERATURE REVIEW

There are many studies such as [17];[8]; [11]; [1]; [3]; [16]conducted on estimating economic efficiency of rice production in the context of different countries. Most of the studies used cost function suited to cross section data. There are few studies in Bangladesh that measured economic efficiency of rice production. For example, [7] has measured economic efficiency of *Boro* rice production in Bangladesh using stochastic frontier approach. The empirical results have showed that the average level of economic efficiency is 0.64. Moreover, land fragmentation, extension of service and land degradation have a negative impact on economic efficiency, while years of schooling, experience of the farmers and credit facilities have a positive impact on economic efficiency. [14] analyzed economic efficiency of *Boro*rice production in northern-central region of Bangladesh. The results have showed that the average level of economic efficiency is 0.69. Seed type and electricity have a negative impact on economic efficiency, while extension services and type of irrigation machine have a positive impact on economic efficiency.[19]has measured the economic efficiency of rice farms in Bangladesh using Cobb-Douglas stochastic cost frontier. The main result showed that the average level of economic efficiency was 0.75. So, there are few studies which explore farm level economic efficiency of *Boro*rice in Bangladesh, focusing on specific study area. The present study will fulfill this gap in the literature.

3. METHODOLOGY

3.1 Empirical Model of Economic Efficiency

Many researchers have used different models to measure economic efficiency of rice production. Empirically, the stochastic cost frontier model was used in this study given by [17]. The following stochastic cost frontier model is applied in the present study:

$$\ln C_i = \alpha_0 + \sum_{j=1}^{3} \alpha_j \ln P_{ji} + 0.5 \sum_{j=1}^{3} \sum_{k=1}^{3} \alpha_{jk} \ln P_{ji} \ln P_{ki} + \alpha_y \ln Y_i + 0.5 \alpha_{yy} \ln Y_i^2 + \sum_{j=1}^{3} \alpha_{jy} \ln Y \ln P_j + V_i + U_i$$

Where, C_i denotes cost of producing rice (taka/*Bigha*) of i^{th} farms; P_1 = cost of labor (taka); P_2 = cost of irrigation (taka); P_3 = cost of fertilizer (taka); Y_i is the output of rice (mound); U_i = stochastic disturbance term that represents farm specific or social economic characteristics related to production efficiency; V_i = random variable associated with disturbances in production and α's are unknown parameters to be estimated.

In efficiency analysis, it is equally important to measure the level of inefficiency and to identify the socioeconomic and farm level characteristics that affect on inefficiency. In the present study in efficiency model given by[17] was applied. Thus, the economic inefficiency model is as follows:

$$\mu_i = \delta_0 + \sum_{j=1}^{9} \delta_j Z_{ji} + \omega_i$$

Where, μ_i represents the inefficiency that is related to exogenous factors or farm specific socio-economic factors of rice production. δ_j's are unknown parameters to be estimated. Z_1 = Total farm size (bigha); Z_2 = household size (numbers); Z_3 = age of the household head (years); Z_4 = education (years of schooling); Z_5= experience of the farmers (years); Z_6 = training (dummy); Z_7 = land fragmentation (number of plots); Z_8 = extension services (dummy); Z_9 = credit facility (taka).

3.2 Study Area and Data Collection Technique

The study is mainly based on primary data. Data were collected by questionnaire method and face to face interview method. This survey was conducted in 2016 on the 2014-15 production years. For selecting the sample area, all difficulties and complexities are taken into account. A total of 112 farm households were selected for this study from *Jhenaidah* district of Bangladesh using multistage random sampling procedure.

4. RESULTS AND DISCUSSION

Some factors such as labor cost, irrigation cost, fertilizer cost and output are important variables to explain economic efficiency of *Boro* rice production. The results of economic efficiency for *Boro* rice production estimated from translog stochastic cost frontier are shown in table 1:

Table 1: Maximum Likelihood Estimation of the Translog Cost Frontier

Variable	Parameters	Coefficient	Standard Error	t-ratio
Constant	α_0	26.26	1.60	16.41*
ln labor	α_1	0.50	9.90	0.05
ln irrigation	α_2	0.29	0.10	2.90*
ln fertilizer	α_3	0.32	0.098	3.26*
ln $(labor)^2$	α_4	0.20	0.11	1.82***
ln $(irrigation)^2$	α_5	0.15	0.02	7.50*
ln $(fertilizer)^2$	α_6	-0.73	1.82	-0.40
ln(labor)*ln(irrigation)	α_7	-0.39	2.35	-0.16
ln(labor)*ln(fertilizer)	α_8	-0.17	2.12	-0.08
ln(irrigation)*ln(fertilizer)	α_9	-0.08	0.029	-2.76*
ln (output)	α_{10}	-2.75	0.55	-5.00*
ln $(output)^2$	α_{11}	0.50	3.12	0.16
ln(labor)*ln(output)	α_{12}	0.15	0.02	7.50*
ln(irrigation)*ln(output)	α_{13}	0.07	0.78	-0.09
ln(fertilizer)*ln(output)	α_{14}	-0.09	1.00	-0.09
Sigma-Squared	σ^2	0.0001	1.00	0.0001
Gamma	γ	0.50	0.20	2.50**
Log likelihood function: 130.65; LR:33.56				

Source: Author' Own calculation; Note: *,**,*** indicate 1%, 5% and10% significance level.

From above table 1 it is cleared that irrigation cost, fertilizer cost and output affected the total cost of *Boro* rice production. It is also cleared that the coefficients of irrigation cost and fertilizer cost were statistically significant. The coefficient of irrigation cost was 0.29 which indicated that 1% increase in irrigation cost will increase the total cost by 0.29%. This result is similar to the result of [7]. The coefficient of fertilizer cost was 0.32 which indicated that 1% increase in irrigation cost will increase the total cost by 0.32%. This result is consistent with the result of [17]. On the other hand, the coefficient of output was also statistically significant. The coefficient of output was 2.75 which indicated that 1% increase in output will decrease total cost by 2.75%. This result is also consistent with the result of [17]. Among four square terms only the coefficient of irrigation square was statistically significant at 1% level of significant and has positive sign. It means that an increase in irrigation cost will increase the total cost of *Boro* rice production. Other square terms were statistically insignificant. Only two interaction variables irrigation*fertilizer and labor*output are statistically significant at 1% level of significant. Other interaction variables were not statistically significant. The estimated value of γ for Boro rice production was 0.50, which means that 50% variation in total production cost among the farmers due to the presence of inefficiencies.

Some socioeconomic and farm level characteristics such as farm size, household size, age, education, experience, training, land fragmentation, extension service, credit facilities are important factors to explain economic inefficiency of *Boro* rice production. The estimated results of the factors affecting on economic inefficiency are shown in table 2.

Table 2: Maximum Likelihood Estimation of Factors of Economic Inefficiency

Variables	Parameters	Coefficients	Standard error	t-ratio
Constant	δ_0	11.45	0.51	22.45
farm size	δ_1	-0.08	0.024	-3.33*
Household size	δ_2	0.036	0.02	1.80***
Age	δ_3	-0.21	0.02	-10.50*
Education	δ_4	0.42	0.22	1.90***
Experience	δ_5	-0.15	0.033	-4.54*
Training	δ_6	-0.10	0.045	-2.22**
Land fragmentation	δ_7	0.015	0.01	1.5
Extension service	δ_8	-0.26	0.03	-8.67*
Credit facilities	δ_9	0.81	0.47	1.72***

Source: Author' Own calculation; Note: *, **, *** indicate 1%, 5% and 10% significance level.

From table 2 it is observed that farm size, age, experience, training and extension service were statistically significant. The sign of the coefficients of all significant variables was negative. The negative sign indicated that an increase in farm size, age, experience, training and extension service will decrease the inefficiency of *Boro*rice production. Household size, Education, land fragmentation and credit facilities were statistically insignificant to explain economic inefficiency.

5. CONCLUSION AND POLICY SUGGESTIONS

Economic efficiency is estimated using translog stochastic cost frontier approach. The model is estimated by the maximum likelihood method. This study indicates that *Boro* rice production in the study area is not fully economically efficient. It is cleared from the analysis that there is a significant variation in economic efficiency in *Boro* rice farmers. The mean economic efficiency of *Boro* rice production is 59.34%. More specifically, 40.66% economic efficiency could be improved if the farmers operate at full efficiency scale. So, the policy makers have to give more attention for reducing the production cost of the farmers by increasing their efficiency levels. On the other hand, inefficiency effect model shows that farm size, age, experience, training and extension service are statistically significant to explain economic inefficiency of *Boro* rice production. So, policy makers have to think how to improve the training and extension service of the farmers. Besides, government should take necessary steps to increase education

level of the farmers and to invent and supply high yielding rice varieties so that farmers can get these at lower price.

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