© Business Review : Volume 10. Number 01 & 02, January to December. 2015. pp. 33-45, Business Administration Discipline. Khulna University, Khulna-9208 (ISSN 1811-3788)

business REVIEW
a journal of business administration discipline

Resource Use Efficiency in Rice Production: A Study on Gopalganj Sadar Upazila of Bangladesh

Md. Ashikur Rahman[1], Nishad Nasrin[2].

Abstract

Purpose: *The study is conducted to determine the relative efficiency of resource use in rice 'Boro' production in Gopalganj Sadar Upazila of Bangladesh on the basis of primary data.*

Design/methodology/approach *: Data has been collected from 80 rice farmers using systematic random sampling. This paper examines the inter-resource use efficiency of rice production and for analysis both Ordinary Least Square and Maximum Likelihood Estimators is used to estimate output elasticity of resources used in production function. Again, value of marginal product of different variables is used to estimate the resource use efficiency and relative efficiency of the input used. Land, labor, fertilizer, pesticide, seed and irrigation are considered as independent variables while output is treated as dependent variable.*

Findings: *The result indicates that only pesticide is being underutilized, whereas, land, labor, fertilizer, seed and irrigation are being over utilized. It is found from analysis that there is a probability of increase in output if the farmers reduce to some extent of those resources which are now being over utilizing. Any increase in use of pesticide may positively affect the production of rice. It is also found that none of the resources is efficiently utilized but seed is relatively efficient in utilization.*

Practical implications: *This research can be used by the researchers who are interested in productivity analysis and can be helpful for policy makers in increasing the amount of rice production without increasing amount of cultivatable land and efficient utilization of the existing resources.*

Key Words: Efficiency, resource utilization, overutilization, underutilization

Background

Bangladesh is a small country which is burdened with a large number of populations, and the size is approximately 148.69 million (World Bank, 2011). Agriculture is the most important occupation and rice is the staple food of its inhabitants. Rice is one of the important agricultural crops, which contributes a significant proportion of the food supply in Bangladesh. Bangladesh is the fourth largest producer of rice (FAOSTAT, 2012) and third largest (FAPRI, 2009) consumer of rice in the world. It plays an important role in socioeconomic development of its inhabitants. It contributes 20.01 percent to total Gross Domestic Product (GDP) of Bangladesh economy. Among the total labor force, 47.30 percent is engaged in agriculture whereas 17.64 percent in industry and 35.06 percent is employed in the service sector (BBS, 2012). In addition, the practice of agriculture is being continued to increase in recent years with the structural adjustment of the Bangladesh economy. The farmers typically produce to satisfy household food requirements or make a profit or both. If the farmer produces agro-product for household consumption, then he tries to produce at an optimum level with his effort. If the farmer produces for the market, then the cost of production and the proceeds accruable to the farmer's effort becomes a significant measure of performance. Either of the two objectives of production requires efficient use of resources. Rice production is carried out with certain inputs or resources which enhance its productivity. The amount to which this productivity can be increased by these inputs depends on how the inputs are used. For instance, when a piece of land is being cultivated, its productivity depends on the resources that are used in it or more precisely on how these resources are being applied. Efficient use of resources has to accomplish with the amount to be used to the land in terms of quantities and their corresponding prices.

[1] Student of MSS, Economics Discipline, Khulna University, Bangladesh e-mail: ashik1015@gmail.com
[2] Assistant Professor, Economics Discipline, Khulna University, Bangladesh e-mail: nishad2015@gmail.com

That is to say the inputs must be used in that quantities which would provide the optimum output and at the same time costs involved in using them must be as low as possible. Hence, when the best resource is used in their optimum quantities and at the minimum possible cost of production of a certain product, then efficient use of resources can be achieved (Nimoh et al., 2012). To cope with the predominant means of poverty and unemployment in Bangladesh, efficiency in resource use is a prerequisite for optimal farm production. Inefficiency in resource use, can distort food availability and food security.

Statement of the Problem

Bangladesh agriculture is dominated by rice production already operating at her land frontier and has no scope of increasing the supply of land to meet the growing demand. To meet up the additional demand, the country imports rice every year and in 2009-2010 the country had to import 0.087 million metric ton of rice. The expansion of crop area was the major source of production growth till 1980s, had exhausted and the area under rice had been started to decline. Again, the farmer of Bangladesh cannot use the resource available for rice production efficiently (Husain et al., 2001). According to Ali and Chaudhry (1990) there would be two possibilities to increase the rice yield and these comprised of efficient use of available resources and increase the area for rice cultivation. Moreover, if efficient use of inputs along with advanced technology has been provided then the productivity may increase. As a matter of fact that it is not possible to increase the supply of land, it is needed to use the existing resources efficiently. It is widely realized that efficiency is at the heart of agricultural production. That is why the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Udoh, 2000). At this stage, the authors have tried to find out the main causes behind the inefficiency in resource use and recommend some necessary steps to increase production without using extra land but using scarce resources efficiently. Now a day, resource use efficiency in agricultural production is a major concern that's why this research concentrates on finding the relative efficiency of the resources that are used in rice production.

Objective of the Study

To examine the inter resource use efficiency of rice production.

Research Questions

i. How efficiently the resources are utilized by the farmers?
ii. What returns to scale do the farmers enjoy in the study area?

Scope of the Study

As Bangladesh is a low resource based economy with huge population, the farmers have to use the existing resources efficiently. This study assesses how efficiently the resources are utilized by the farmers. Researchers try to determine those factors that influence inefficiencies in the utilization of those scarce resources in Boro rice production. It will help to raise amount of rice production without increasing amount of cultivable land and efficient utilization of the existing resources.

Review of Literatures

Efficiency in general, describes the extent to which time, effort or cost is well used for the intended task or purpose. Efficiency is the ability to produce at a given level of output at lowest cost (Farrell, 1957). Economic efficiency can be defined as the increase in output from the given level of conventional inputs using the existing technologies in a cost effective way (Grabowski, 1985; Shapiro and Müller, 1977). Three types of efficiency are identified in the literature, namely technical efficiency, allocative efficiency and overall or economic efficiency (Farrell, 1957; Olayide and Heady, 1982). Technical efficiency is the ability of a farm to produce a given level of output with a minimum quantity of inputs under a given technology. Allocative efficiency is a measure of the degree of success in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of these inputs. Economic efficiency is a product of technical and allocative efficiency (Olayide and Heady,

© Business Review : Volume 10. Number 01 & 02, January to December. 2015. pp. 33-45, Business Administration Discipline. Khulna University, Khulna-9208 (ISSN 1811-3788)

1982). In one sense, the efficiency of a farm is its success in producing as large amount of output as possible from given set of inputs. Nimoh et al. (2012) have used Cobb-Douglass production function to estimate the coefficients of the various variables and Marginal Physical Product (MPP), Marginal Value Product (MVP) and allocative efficiency index used to estimate the efficiency of resource use in their study at Ghana. The regression results showed that the farmers were in the second stage of production, which is, decreasing returns to scale. Efficiency computation indicated that land, fertilizer and seed were being underutilized and labor and chemicals being highly over utilized. Ominyi (2012) assesses resource use efficiency using Maximum Likelihood Estimation (MLE). The author has shown that all estimated coefficients among various farm operation indicates have positive sign which implies that an increased quantity of inputs would increase the output of rice. The results obtained from the inefficiency model indicates that the resource use in rice production in the study area was not fully utilized in all the categories of farms examined, although farmers were generally relatively efficient, they still have room to increase the efficiency of their farming activities. The technical returns to scales measured by the sum of the elasticity of all significant factors have showed that small and large scale exhibited increasing return to scale while medium scale farms demonstrated decreasing return to scale, but for pooled observation it depicts constant return to scale. The study recommended that farm inputs should be made available to farmers at highly subsidized rates and makes them available timely, through adequate supply and efficient distribution. Again, high yield with efficient use of resources is accompanied by less intrinsic valuation, large input costs and environmental sustainability (Pretty et al., 2000; Keating et al., 2010). A lot of research has been carried out on relative resource use efficiency. Tijani et al. (2010) has found that resources such as fertilizer, hired labor and rented land were under-utilized. The sum of elasticity's of production indicates that there is increasing return to scale. It suggested that farmers should be advised to increase use of rented land, improved rice seed, fertilizer, hired and mechanical labors and chemicals. They should be encouraged to keenly participate in adult education and extension programme to acquire knowledge on how to use their farm resources efficiently in rice production. It revealed that fertilizer, labor and land were being used inefficiently hence below optimum economic level (Sani et al., 2010). This was attested by the high ratios of MVP/MFC of all the variables. For optimum resource allocation to fertilizer, labor and land about 86 percent, 83.3 percent and 69 percent increase in MVP is required respectively. The estimated elasticity of production summed up to 0.815 meaning decreasing return to scale.

The resource use efficiency could not be achieved without better arrangements of farming, extension of services and government intervention. The fixed land frontier is the main reasons for the problems in crops farming. Without advanced farming, farmers could not achieve the optimum level of production. The land tenure system and limited knowledge of the farmers regarding farming in the rural parts of developing countries also adds problems to inefficient resource use in farming. As the farmers are not well educated, they don't know the better utilization of their scarce resources. Therefore, the researchers concentrate on measuring relative efficiency of the resources by including variable namely irrigation cost, land size, labor, fertilizer, pesticide/insecticide, and seeds for rice production in the study area using Cobb-Douglas production function and Maximum Likelihood Estimation based on collected data from the study area.

Methodology and Theoretical Framework

Gopalganj Sadar Upazila of Gopalganj district has been selected for the study purpose where many of rural households engage in agricultural activities. There are 21 unions in the study area and Jalalabad Union has been selected purposively because most of the farmers in the area are engaged in rice cultivation.

There are 11 villages in this union. Among them, 4 villages are randomly selected. Under this upazila, total farm holding is 38707, owner holding is 39631, owner cum tenant is 18423 and tenant holding is 5783. As specifically how many people are engaged in paddy cultivation is treated as the population for this study. These villages those are taken randomly are namely, *Borfa*, *Chutofa*, *Ischakhali, and Dhalaitala*. Farmers cultivating *Boro* rice as main

crop in the study area are considered as population. To accomplish the research paper, 80 rice producing farmers who have their own land have been considered. By using systematic random sampling technique 20 farmers are selected from each village. Data have been collected through interview schedule method, which is asked and filled with the interviews in a face-to-face interview situation. For this purpose, a questionnaire has prepared. Secondary data have been taken from selected published books, journals, annual economic reports, the ministry of agriculture website, Bangladesh Bureau of Statistics and selected working papers. In Bangladesh, rice is grown in three distinct seasons: *Boro* (post-monsoon rice) from January to June, *Aus* (pre-monsoon rice) from April to August, and *Aman* (monsoon rice) from August to December. Of the three types of rice, *Boro* rice alone contributes about 55 percent of total food grains and also highest in productivity (3.84 Metric Ton/per hectare) compared to *Aus* rice (1.76 MT per hectare) or *Aman* rice

Table 1: Variables Used in the Study

Explanatory Variables	Description of Variables	Expected Sign	Unit of Measurement	Literature Reference
X_1	Land size	+	in bigha	Ominyi (2012)
X_2	Labor	+	in man days	(Sani et al., 2010)
X_3	Fertilizer	+	kg/bigha	(Tijani et al., 2010)
X_4	Pesticide/insecticide	+	liters/bigha	(Nimoh et al., 2012)
X_5	Seeds	+	kg/bigha	(Sani et al., 2010)
X_6	Irrigation cost	+	BDT/bigha	(Nimoh et al., 2012)
Dependent Variable	**Description of Variable**		**Unit of Measurement**	**Literature Reference**
Y	Output		Maund/bigha	(Tijani et al., 2010)

Source: Authors' Compilation, 2014

(2.16 MT per hectare). However, the average rice yield in Bangladesh was 2.81 tons/hectare in 2008-2009 (BBS, 2012) which is much lower compared to those of other Asian countries such as China, South Korea, Indonesia, Japan, and Vietnam. As *Boro* rice supporting more than others and it is cultivated as huge amount as it can change the present condition of food deficit. Therefore, the researchers have selected *Boro* rice and those farmers who are cultivating *Boro* rice.

Output variation is caused by mainly fluctuations in inputs, inefficiency in resource use and random shocks. They articulate that contribution of inputs can be captured through a production function specification and variation in output due to technical inefficiency and random shocks can be decomposed through stochastic production (parametric approach) frontier approach (Abedullah et al., 2007).

In Cobb-Douglas production function total output regarded as dependent variable and other six variables (land size, labor, fertilizer, pesticide/insecticide, seeds, and irrigation cost) are considered as independent variable shown in Table 1. Where, output is measured in maund, land in bigha and labor in man-day. On the other hand, fertilizer, pesticide and seed are measured in kg but irrigation is measured in Bangladeshi Taka (BDT) expend in a season.

The Empirical Model: Now the empirical model of the logarithmic form of the estimated Cobb-Douglas production function is given as below:

$$\ln Y = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + u_i$$

© Business Review : Volume 10. Number 01 & 02, January to December. 2015. pp. 33-45, Business Administration Discipline. Khulna University, Khulna-9208 (ISSN 1811-3788)

Where, Y = Total output of rice of the farm (maund)

X_1 = Land size (bigha)

X_2 = Total labor used in crop production (no. ofman days)

X_3 = Fertilizer used (kg)

X_4 = Pesticide/insecticide used (liters)

X_5 = Quantity of seeds used in cultivation (kg)

X_6 = Irrigation cost (In taka)

u_i = Error terms

β_0 = Intercept

β_{1-6} = Coefficients to be estimated

Returns to Scale $= \sum \beta_i$

Elasticity ( ) $= \frac{\partial \ln Y}{\partial \ln X_i} = \beta_i$

Marginal Productivity (MPX_1) $= \frac{\partial \ln Y}{\partial \ln X_i} \times \frac{Y}{X} = \square \times \frac{\bar{Y}}{\bar{X}}$

$MPX_1 = e_x \times \frac{\bar{Y}}{\bar{X}}$

Value of Marginal Product (VMP_X) = $MP_X \times P_Y$

Where, P_Y = Mean price of the output

Resource use efficiency r = $VMP_X/MFC_X = 1$

Where, MFC_X = Marginal factor cost of input X

The prevailing market price of inputs is used as the marginal factor cost (MFC).

Where, If r = 1, implies the resource is being efficiently utilized

If r >1, it shows that the resources is being underutilized and increasing the rate of use will raise efficiency.

If r <1, it means the resource is over utilized, hence decreasing the quantity of that resource will increase efficiency.

Socio-economic Status of Rice Farmers

Age-Sex Distribution: Age is the important influential factor for agro product cultivation as well as rice cultivation. Older farmers are less energetic than younger in farming activities. Male workers are able to work more and complicated work than their counter part. Hence, age and sex structure of the respondent is vital for the study.

Table 2: Age-Sex Distribution of the Farmers

Age Frequency (Year)	Number	Male	Percent
0-19	-	-	-
20-29	15	15	18.75
30-39	27	27	33.75
40-49	25	25	31.25
50-59	11	11	13.75
60- Above	2	2	2.5

Source: Author's Calculation Based on Field Survey, 2014

From the Table 2 it is clear that participation by the farmer in rice cultivation of age group 30-39 is mentionable. Around 33.75 percent of the respondents are from that group. It indicates that around 18.75 percent of the

respondent from age group 20-29, around 31.25 percent of the respondent from 40-49 age group, around 13.75 percent of the farmer from the age group 50-59 and only 2.5 percent are form 60 and above age group. The entire respondents are male, as there is no female worker working in the rice cultivation in the study area.

Educational Status: Education is one of the most important variables of socio-economic development and efficiency. If the farmers are educated and trained enough then they will be able to apply modern technologies in the cultivation of agro products. Thus, they can attain efficiency at their resource utilization for rice cultivation.

Table 3: Educational Status of the Farmers

Category	Year of Schooling	Frequency	Percent
Illiterate	0	12	15
Primary	0-5	19	23.75
Secondary	6-10	43	53.75
Higher Secondary	11-12	4	5
Graduate	13-16	2	2.5
Total	-	80	100

Source: Author's Calculation Based on Field Survey, 2014

Table 3 depicts that most of the respondents of the study are about to complete or at least attend secondary school. The secondary group consists of 43 respondents; on the other hand, 15 percent farmers from the total have no formal education. However, 19 (23.75 percent) respondents have primary education only; along with this 4 respondents (5 percent) have gone through higher secondary education. Higher educated people are also present there and their number is 2 (2.5 percent), which is very low.

Farming Experience: Framing experience works as an indicator of efficiency and expertise. We know that division of labor helps a worker to produce more than what he was producing before. Performing the same task again and again the worker prove himself as an experienced and efficient one.

Table 4: Farming experience of the Farmers

Farming experience (Year)	Frequency	percent
0-9	27	33.75
10-19	31	38.75
20-29	13	16.25
30-40	9	11.25
Total	80	100

Source: Author's Calculation Based on Field Survey, 2014

From the Table 4, it is seen that 33.75 percent households have the farming experience of 0 year to 9 years while 38.75 percent have the experience of 10 years to 19 years, 16.25 percent have 20 years to 29 years and 11.25 percent have the farming experienced between 30 to 40 years.

Ownership Pattern of the Land: The researchers have found from the field survey that all the households live on their own land. This study is focusing those households who are working on their own land.

Types of Farm Household: Land size is one of the most significant farm specific characteristics in the field of agricultural economics. The researchers divide farm households into four categories on the basis of size of the

cultivable land. The categories along with land size are: marginal farm households are regarded whose land size is (<0.5 acres or 0-1.5 bigha), small farm households (0.5≤ to<1.67 acres or 1.5 to 5 bigha), medium farm households (1.67≤ to ≤5 acres or 5-15 bigha), and large farm households (5+ acres or over 15 bigha)

Table 5: Types of Farm Household

Types of Farm Household	Land Size (in acres and bigha)	Frequency	percent
Marginal	(<0.5 acres or 0 to1.5 bigha)	25	31.25
Small	(0.5≤ to <1.67 acres or 1.5 to5 bigha)	45	56.25
Medium	(1.67≤to ≤5 acres or 5 to 15 bigha)	8	10.00
Large	(5+ acres or over 15 bigha)	2	2.5
Total		**80**	**100**

Source: Author's Calculation Based on Field Survey, 2014

Table 5 shows that among 80 households, 25 respondents are marginal farmers, 45 respondents are small farmers, and 8 respondents are medium farmers. From the survey the researchers have found that only 2 rice farmers are regarded as large farm households. Thus, small farm households are dominant in the study area.

Use of Labor: Labor is one of the factors of production and it is the main element of agricultural production in Bangladesh. Labor is available and cheap compared to other inputs in the country. Table 7 shows the labor used in man day per bigha in rice cultivation.

Output Produced: Output is the ultimate goal of production activity. Farmers try to maximize their output with the limited resources available to them. The outputs of the respondents of the study are shown in Table 6 and it is seen that most of the farms output lies in 24-28 maund/bigha, whereas 6.25 percent farms output are between 13-18 maund, 23.75 percent are between 19-23 maund, 22.5 percent are between 29-33 maund and only 8.75 percent of the farms output are between 34-38 maund/bigha.

Table 6: Farm Output

Output (maund/bigha)	Frequency	Percent
13-18	5	6.25
19-23	19	23.75
24-28	31	38.75
29-33	18	22.5
34-38	7	8.75
Total	**80**	**100**

Source: Author's Calculation Based on Field Survey, 2014

Fertilizer Use: Rice farmers have two distinctive periods for fertilizing their crops pre-flood and post-flood. Spreading is done by water movement and during land preparation. Inorganic fertilizers are hand-spread and where essential, incorporated by harrowing.

Pesticides Use: The increased pressure to maintain high level of rice production for consumption has resulted in increased use of pesticides on rice fields. Pesticide has contributed significantly to the progress towards the food self-sufficiency in Bangladesh through increasing total output by protecting green leaf.

Types of Seed: To mitigate food deficiency problem from Bangladesh it is currying needed to increase the production of foodstuff as well as rice. Healthy rice seeds using are pre-requisites for accelerate agricultural growth and solving food deficit problem. The researchers have found the farmers to use three types of seeds named Local, Hybrid and High Yielding Variety (HYV) for rice cultivation in their land.

Irrigation Cost: Modern rice farmers, such as those in Bangladesh, use irrigation to cultivate rice. In this method, rice farmers are able to manage the flow and amount of water need to produce the rice. Irrigation insures that the farmer will get a lot of rice and a quality grain. It has been seen from Table 7, 41.25 percent of total farmer use labor 24-28 man days per bigha to cultivate rice. Whereas, 3.75 percent farmers use 13-18 man days' labor, 28.75 percent farmers use labor 19-23 man days and 20 percent farmers use 29-33 labor man days per bigha. However, only 6.25 percent farmers use 34-38 labor man days per bigha. It is observed that most of the rice producers use 32.5 percent of fertilizer within 40-49 kg/bigha at the time of rice farming. Whereas, 21.25 percent households use 20-29 kg, 27.5 percent households use 30-39 kg, 10 percent respondents use 50-59 kg and 6.25 percent rice farmers use 60-69 kg fertilizer/bigha.

Table 7: Inputs Utilization in Rice Production

Name of Input	Unit of Measurements	Range	Frequency	percent
Labor	man days/bigha	13-18	3	3.75
		19-23	23	28.75
		24-28	33	41.25
		29-33	16	20
		34-38	5	6.25
Total	-	-	**80**	**100**
Fertilizer	kg/bigha	20-29	17	21.25
		30-39	22	27.5
		40-49	26	32.5
		50-59	8	10
		60-69	5	6.25
		Over 70	2	2.5
Total	-	-	**80**	**100**
Pesticide	Kg	0.00-0.249	16	20
		0.250-0.499	23	28.75
		0.500-0.749	20	25
		0.750-0.999	5	6.25
		1.0-1.999	10	12.5
		Over 2.0	6	7.5
Total	-	-	**80**	**100**
Irrigation Cost	BDT/bigha	1000-1199	10	12.5
		1200-1399	29	36.25
		1400-1599	23	28.75
		1600-1799	10	12.5
		1800-2000	8	10
Total	-		**80**	**100**
Seed type	Kg	Production (maund)	-	-
Local		16-25	18	22.5
HYV		22-30	26	32.5
Hybrid		25-38	36	45
Total	-	-	**80**	**100**

Source: Author's Calculation Based on Field Survey, 2014

© Business Review : Volume 10. Number 01 & 02, January to December. 2015. pp. 33-45, Business Administration Discipline. Khulna University, Khulna-9208 (ISSN 1811-3788)

Only 2.5 percent of the households use more than 70 kg fertilizers per bigha. The Table 7 expresses that 20 percent of farm households use less than 0.249 kg pesticide in their land for rice cultivation. Most of the farmer using pesticide falls in the group 0.250-0.499 kg. Except this, 25 percent of the households use 0.500-0.749 kg, 6.25 percent use 0.750-0.999 kg, 12.5 percent use 1.0-1.999 kg and 7.5 percent of the farmer uses over 2 kg of pesticide in their land.

Table 7 depicts that 22.5 percent of the households are using local seeds and the production amount is 16-25 maund/bigha whereas 32.5 percent farmers are cultivating with (HYV) and they are getting 22-30 maund/bigha. However, 45 percent of the respondents use hybrid seeds and get 25-38 maund/bigha of rice. The author has found from the above table 7 most of the farmers (36.25) expenditure on irrigation is ranging from BDT 1200-1399/bigha. Conversely, only 10 percent of the farmers incur BDT 1800-2000 as irrigation cost.

Other Farm Characteristics: There are some other characteristic of the farm that influence rice production. These factors are ownership of the farm, source of achievement of the farm, distance of the plot from house of the farmer, distance of the market where to sell the final product, number of plots that a farmer has and amount of land that the farmer is cultivating.

Table 8: Farm Characteristics

Variables	Category	Frequency	Mean	Maximum	Minimum
Farm inheritance	1 Yes, 0 no	65, 15	0.825	No	No
Distance of plot from house (km)	0.01-0.74	27	1.05875	3	0.1
	0.75-1.49	34			
	Over 1.5	19			
Distance of local market (km)	2-3.9	33	4.55625	10	2
	4-5.9	26			
	Over 6	21			
Plot number	1-1.9	28	2.2625	12	1
	2-3.9	44			
	Over 4	8			
Land size (bigha)	(Small) 0.25-0.9	13	1.53875	6	0.25
	(Medium) 1-1.9	43			
	(Large) Over 2	24			

Source: Author's Compilation Based on Field Survey, 2014

From Table 8, it is clear that these factors are influencing farm's production. From the survey, the researchers have found that 65 farmers out of 80 get the land by inheritance and their mean is 0.825. Most of the farmers plot distance is 0.75-1.49 kilometer from his house and the average distance is 1.06 kilometer. Distance of the local market where the farmers sell their product is 2-3.9 kilometers from their field. Mean distance of the market from the house of the respondents is 4.56 kilometers, whereas maximum distance is 10 kilometers but the minimum is 2 kilometers. Most of the farmers plot number is between 2 to 3.9 and the average is 2.26. Land size varies considerably, but most of the farmers land is within 1-1.9 bigha which is regarded as medium in the table. However, the average size of the farm is 1.54 bigha.

Results and Discussion

Inputs and Outputs, Factor Price and Market Price: From the field survey, the researchers have found that the households are producing 26.16 maunds of boro rice per bigha on an average. The production of rice varies between 16.38 and 38 maunds/bigha with 5.41 standard deviations. Table no. 9 shows that cultivable land size is 3.22 on an average whereas; the land size varies from 0.25 bigha to 18 bigha with 2.68 standard deviations. Farmers employ 25.09 man-days per bigha while production of rice in one season but the amount varies from 14.2 to 44 man-days

© Business Review : Volume 10. Number 01 & 02, January to December. 2015. pp. 33-45, Business Administration Discipline. Khulna University, Khulna-9208 (ISSN 1811-3788)

with 4.82 standard deviations. The farmers use 40.15 kilograms of fertilizer per bigha on an average but the rate goes from 20 to 75 kilograms with standard deviations of 11.95. The author quantifies the use of pesticide by 0.74 kg/bigha but the rate varies between 0.1 to 1.2 kg/bigha with 0.93 standard deviations. The households use 9.90 kg/bigha of seeds on an average in their land but the rate varies between 6.5 to 16.15 kilograms with standard deviations of 1.83.

Table 9: Output, Inputs, Factor Price and Market Price

Variables	Unit of Measurement	N	Mean	S.D.	Min.	Max.
Quantity produced	Maund	80	26.16	5.41	16.38	38
Land	Bigha	80	3.22	2.68	0.25	18
Labor	Days/bigha	80	25.09	4.82	14.2	44
Fertilizer	Kilograms/bigha	80	40.15	11.95	20	75
Pesticides	Kilograms/bigha	80	0.74	0.93	0.1	1.2
Seed	Kilograms/bigha	80	9.90	1.83	6.5	16.15
Irrigation	BDT/bigha	80	1418.51	225.72	1000	2000
Costs, Factor Price and Market Price						
Output Price	BDT/maund	80	771.81	93.52	700	850
Land Preparation	BDT/bigha/season	80	1369.39	255.67	800	2000
Labor	BDT/days	80	284.31	34.21	200	350
Fertilizer	BDT/kilograms	80	21.68	1.97	17.5	27
Pesticides	BDT/kilograms	80	1762.38	133.93	1430	2250
Seed	BDT/kilograms	80	59.88	16.39	30	80

Source: Author's Calculation Based on Field Survey, 2014

N.B.: N = Observation, S.D. = Standard Deviation, Min. = Minimum, Max. = Maximum

Farmers incurred BDT 1418.51/bigha with the standard deviation 225.72 kg/bigha. The maximum amount of expenditure according to field survey on irrigation is approximately BDT 2000/bigha, while, the minimum expenditure is BDT 1000/bigha.

Measurement of Efficiency Using OLS and MLE: The authors go through some tests to choose the appropriate specification of the production function for measuring relative efficiency of resources. The results of this testing support Maximum Likelihood Estimator as the result shows that error terms are not normally distributed. The OLS production function has some lacking as efficient estimator and OLS estimator requires the normally distributed data. The Maximum Likelihood Estimation (MLE) shows the best practiced performance that is efficient use of input. Therefore, the authors have used both the Maximum Likelihood Estimation (MLE) and Ordinary Least Squares (OLS) to analyze the production function for checking robustness and measuring the factor use efficiency. The statistics of Log Likelihood Ratio is statistically significant at 5 percent level which is an indicator of inefficiency (see table 9) in the model. Moreover, the variance of one sided error term $\ln\sigma^2_u$ (variance of inefficiency term) is significant at 1 percent level of significance but the variance of two sided error term $\ln\sigma^2_v$ (variance of error term) is not statistically significant. These results indicate the presence of inefficiency in the model. The authors show the values of OLS and MLE estimates of the parameters of Cobb-Douglas production function in the table 10. The value of R^2 from OLS is 0.28 which indicates that about 28 percent of the variation in rice cultivation is explained by the variation of inputs for the study area. Both OLS and MLE estimation gives the similar result that,

land gives negative sign though the value of OLS is not statistically significant. On the other hand, the co-efficient MLE is significant at 1 percent level which implies that any positive change (increase in land of land compared to other input) in land will decrease the level of production, moreover Ominyi (2012) have found that land giving the similar result in his research. The regression co-efficient of both the estimator for labor shows negative sign which is contradictory to the findings of Sani et al. (2010) where they have found positive result between production amount and labor used. The result of OLS shows that if the household increases labor by 1 percent then this will let in output to decrease by 0.4 percent which is significant at 5 percent level and MLE result shows the output decrease by 0.07 percent which is significant at 1 percent level if other things remain constant.

Co-efficient of fertilizer from OLS estimation is not statistically significant. Moreover, the co-efficient of MLE is showing the same sign that are 1 percent increase in fertilizer use induced 0.59 percent decrease in output holding other factors constant which is statistically significant at 1 percent level. The authors finding is contradictory with the finding of Tijani et al. (2010). OLS estimator showing negative result of pesticide use and output but the MLE shows positive sign.

MLE result shows 1 percent increase in pesticide would increase the output by 0.016 percent. Same result has found by Nimoh et al. (2012), when he used OLS regression for pesticide use.

The value of both OLS and MLE indicate that if the amount of seed use for cultivation is increased then output will also increase considering all other factors remaining same which is significant at 1 percent level. Both OLS and MLE estimators have given the same results. These estimators have been showing that land gives negative sign but the value of OLS is not statistically significant. On the other hand, the value of MLE is significant at 1 percent level of significance which implies that any positive change in irrigation cost will increase the level of production; moreover Nimoh et al. (2012) have found land giving the same result in his research.

Table 10: OLS and Stochastic Frontier

Variables	Cobb-Douglas	
Dependent variable: Ln(output)	(1)	(2)
	OLS	MLE
ln (Land in Bigha)	-0.16	-0.19***
	(0.10)	(6.31e-06)
ln (labor per man-day)	-0.44**	-0.071***
	(0.18)	(4.08e-05)
ln (Fertillizer/kg)	-0.26	-0.59***
	(0.23)	(5.56e-05)
ln (Pesticide/kg)	-0.019	0.016***
	(0.28)	(5.81e-05)
ln (Seed/kg)	0.21***	0.14***
	(0.06)	(1.60e-05)
ln (Irrigation/BDT)	0.05	0.17***
	(0.12)	(2.70e-05)
Constant	6.59**	5.13***
	(2.57)	(0.000516)
Variance parameter:		
$\ln\sigma^2_v$	-	-37.34
		(288.8)
$\ln\sigma^2_u$	-	-2.36***
		(0.15)
Log Likelihood Ratio	-	21.13**
N	80	80
R^2	0.28	-

$^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$

Source: Authors Calculation Based on Field Survey, 2014

Estimation of Relative Efficiency: Table 11 shows the calculation of efficiency of resources used in the study area. Factor price is determined by the prevailing market price. Marginal Productivity (MP) and Value of Marginal Product (VMP) for land, labor and fertilizer is negative. Whereas, the value of MP and VMP of pesticide, seed and irrigation cost are positive. Table 12 shows the relative efficiency of the resource use of the household and the present scenario of resource use pattern. The result shows that the ratio of value of Marginal Product of land

($VMPX_I$) to Marginal Factor Cost of Land ($MFCX_I$) is –0.88 (less than one) implies that land is over utilized and any increase in land amount will decrease the total output.

Table 11: Measurement of Efficiency

Resources	Mp	VMP	MFC	R
Land	- 1.55	- 1196.6	1359.39	- 0.88
Labor	- 0.08	- 61.76	7133.34	- 0.0086
Fertilizer	- 0.39	- 301.08	870.45	- 0.35
Pesticide	5.67	4377.24	1304.16	3.36
Seed	0.38	293.36	592.41	0.50
Irrigation	0.0032	2.47	1418.51	0.0017

Source: Author's Calculation Based on Field Survey, 2014

Table 12: Relative Efficiency of Resources

Resources	Value of (r)	Result
Land	- 0.88	Over utilization
Labor	- 0.0086	Over utilization
Fertilizer	- 0.35	Over utilization
Pesticide	3.36	Under utilization
Seed	0.50	Over utilization
Irrigation	0.0017	Over utilization

Source: Author's Calculation Based on Field Survey, 2014

Other two factors of production, labor and fertilizer are also over utilized and the value of r is -0.0086 and -0.35 respectively. Thus, Marginal returns are likely to decrease with the increase of land, labor and fertilizer. Generally, factor market is inefficient in the underdeveloped and developing countries. The ratio of value of marginal product (VMP) of pesticide, seed and irrigation to marginal factor cost of pesticide, seed and irrigation (MFC) are 3.36, 0.50 and 0.0017 respectively implies that the pesticide is underutilized. Other two resources seed and irrigation are over utilized as their value of r is less than 1. Therefore, there is possibility to increase marginal return by increasing the amount of pesticide. Whereas, the amount of output will decrease if seed and irrigation cost will increase. From the above calculation and observing the Table 12, it can be said that resource seed is relatively efficient in use then other resources. None of the resources are efficiently utilized but seed is relatively efficiently utilized in the study area.

Findings of the Study

All the farmers in the study area are male and most of them are between 30-39 age groups. More than half of the respondent's educational qualification is up to secondary school level. Along with this approximately 39 percent of the respondents have around 10-19 years of farming experience. The researchers again found that 56 percent of the households are small scale farmers having land size 0.5≤-<1.67 acres or 1.5-5 bigha. However, it is seen that on an average, the production of rice is 26.16 maunds per bigha. Whereas, average labor use per bigha is 25.09 man-days along with this fertilizer 40.15 kg, pesticides 0.74 kg, seed 9.90 kg, and irrigation cost is 1419 BDT per bigha. The estimation of OLS production function showing that all inputs excluding seed and irrigation cost have negative impact on production. This is because the farmers get seed in a low price and the land of this area becomes flooded by natural water. Most of the cases the seeds are used in rice cultivation is produced by the farmers that is why the cost of seed is low in this location. The cost of pesticides is high for this area. Farmers use fertilizer more than the actual need and so as the labor. Again, the MLE shows land, labor and fertilizer has negative impact and the other have positive impact on production while OLS production function is inadequate in representing the data. It is also suggested that there the variation of output which is caused by the presence of inefficiency in factor used in rice production. Furthermore, the study reveals that the land, labor, fertilizer, seed and irrigation are overutilized while pesticide is underutilized. Efficient use of fertilizer, irrigation and other inputs of production can increase output and it is found that increased utilization of pesticide can enhance production volume of rice.

Concluding Remarks

The study shows that the resource use in rice production in the study area is not efficient in all the categories of farms examined. This can happen due to the ignorance of the farmers or lack of proper knowledge of farming. Over utilization of land has to be stopped as soon as possible in order to get maximum production from land. Labor should have to be withdrawn from agro land and transform to off-farm activity. The government should strengthen

the local agricultural authorities so that they can provide better service to the farmers. They can supervise the input price along with its quality, which is distributed by the dealer. Price of other inputs (pesticide, seed and irrigation) should be reduced, so that the households can increase using these inputs. Along with this, the extension activities of the agricultural agents should be revived so that farmers will make improved technical decision and also help in allocating their production input effectively, this will make local rice a good substitute for imported ones. Non-governmental organizations along with research institutes in cooperation with the farmers' cooperative groups should provide developed agricultural technologies such as improved seeds, fertilizer at reasonable rate to the farmers.

References

Abedullah, Kouser, S. and Mushtaq, K. (2007). Analysis of Technical Efficiency of Rice Production in Punjab (Pakistan): Implications for Future Investment Strategies, *Pakistan Economic and Social Review*, pp. 231-244.

Ali, M. and Chaudhry, M.A. (1990). Inter-regional farm efficiency in Pakistan's Punjab: a Frontier Production Function Study, *Journal of Agricultural Economics*, 41(1), pp. 62-74.

BBS (2012). '*Bangladesh Economic Review 2012*', Bangladesh Bureau of Statistics (BBS), Ministry of Finance, Government of The People's Republic of Bangladesh, Dhaka.

BBS (2013). '*Bangladesh Economic Review 2013*', Bangladesh Bureau of Statistics (BBS), Ministry of Finance, Government of The People's Republic of Bangladesh, Dhaka.

FAOSTAT (2012). '*FAO Statistical Yearbook 2012*' Food and Agriculture Organization of the United Nations (FAOSTAT), United State of America.

FAPRI (2009). Agricultural Policy Research Institute, *2009, US and World Agricultural Outlook*.

Farrell, M. J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society. Series A (General)*, pp. 253-290.

Grabowski, R. (1985). Technical Efficiency in Nepalese Agricultural, *The Journal of Developing Areas*, 19(4), 515-526.

Husain, A.M., Hossain, M. and Janaiah, A. (2001).*Hybrid Rice Adoption in Bangladesh: A Socioeconomic Assessment of Farmers' Experiences*, Research and Evaluation Division, BRAC.

Keating, B.A., Carberry, P.S., Bindraban, P.S., Asseng, S., Meinke, H. and Dixon, J. (2010). Eco-efficient Agriculture: Concepts, Challenges, and Opportunities, *Crop Science*, 50(Supplement_1), pp. S-109-S-119.

Nimoh, F., Tham-Agyekum, E.K. and Nyarko, P.K. (2012). Resource Use Efficiency in Rice Production: the Case of Kpong Irrigation Project in the Dangme West District of Ghana, *International Journal of Agriculture and Forestry*, 2(1), pp. 35-40.

Olayide, S.O. and Heady, E.O. (1982). *Introduction to Agricultural Production Economics*, Ibadan University Press, University of Ibadan.

Ominyi, S.O. (2012). Resource Use Efficiency and Rice Production in Guma Local Government Area of Benue State: An Application of Stochastic Frontier Production Function, *International Review of Social Sciences and Humanities*, 3(1), pp. 108-116.

Pretty, J.N., Brett, C., Gee, D., Hine, R., Mason, C., Morison, J., Raven, H., Rayment, M. and Van der Bijl, G. (2000).An assessment of the Total External Costs of UK agriculture, *Agricultural Systems*, 65(2), pp. 113-136.

Sani, A., Yakubu, A. and Bello, H. (2010).Resource-Use Efficiency in Rice Production under Small Scale Irrigation in Bunkure Local Government Area of Kano State, *Nigerian Journal of Basic and Applied Sciences*, 18(2).

Shapiro, K.H. and Müller, J. (1977). Sources of Technical Efficiency: The Roles of Modernization and Information, *Economic Development and Cultural Change*, pp. 293-310.

Tijani, B., Abubakar, M., Benisheik, K. and Mustapha, A. (2010). Resource Use Efficiency in Rice Production in Jere Local Government Area of Borno State, Nigeria, *Nigerian Journal of Basic and Applied Sciences*, 18(1), pp. 27-34.

Udoh, E.J. (2000). *Land Management, Resources Use Efficiency Among Farmers In South Eastern Nigeria*, Unpublished Ph.D Thesis, Department of Agricultural Economics, University of Ibadan.

World Bank (2011).'*World Bank Data Base: Bangladesh*', World Bank.