

Resource-Use Efficiency in Irrigated Rice Production in Yobe State, Nigeria

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ABSTRACT

This study examines the resource-use efficiency in irrigated rice production in Yobe State. Primary data was used in the analysis. The analytical tool used was stochastic frontier production function using the maximum likelihood estimation (MLE) which was applied on cross sectional data of 384 sampled farmers. The result from the MLE reveals that farmers performed at an average technical efficiency of 73%, 83% and 86% for small, medium and large scale farmers respectively. The technical return to scale show that all categories of farmers exhibited increasing returns to scale but the large scale farmers were closer to stage two which is the rational stage of production process. The ratio of MVP to MFC of all inputs were greater than one indicating that all inputs except labour were under utilized in the study area. Base on the findings, it is recommended that the small and medium irrigated rice farmers can pool their resources together to derive the economies of larger scale production since the fall in output from maximum efficiency level is less for the large scale farmers; also the fact that the large scale farmers are closer to stage two of the production process which is the rational stage of production.

Keywords: *Resource use efficiency, irrigated rice production, Yobe State*

INTRODUCTION

Rice is grown primarily for human consumption. It is estimated that half of the world's population depends on rice as its main sources of calories (IRRI, 2001). An average Nigerian consumes 24.8kg of rice per year representing 9% of calorie intake (FAO, 2001). Rice marked the 6th in Nigeria in terms of production in relation to crops like sorghum, millet, cowpea, cassava and yam (Singh et al 1997). A part from human consumption, the other parts of rice plant such as straw and bull are used as animal feed, fertilizer, animal bedding and roofing materials and for other purposes (FAO, 2007). The demand for

rice has been increasing at a much faster rate in Nigeria than in other West African countries (Moses and Adebayo, 2007). The increase in rice demand according to FAO (2001) is attributed to a consumer shift from traditional staples such as yam, gari to imported parboiled rice. FAO (2000) reports that as income of families increase, there would be a shift in consumption pattern from roots and tubers to rice. Akande (2002) sees urbanization as a major cause of the shift in consumer preferences towards rice in Nigeria. Rice is easy to prepare compared to other traditional cereals and therefore fit more easily in urban life style of rich and poor (Akande, 2002).

Rice therefore contributes a significant proportion of food requirement of the population. Because of the importance of rice in food and non food uses and its position in Nigeria agriculture, it is imperative to examine the efficiency of the resources used in its production. The high dependence on importation of food including rice to meet the needs of Nigerians is remarkably an evidence of food insecurity in the country that can be addressed by articulated and realistic food production strategy. According to strategy report, Nigeria's estimated annual rice demand is put at 5 million metric tones while the annual production average is estimated to be 2.21 million tones. There exists a deficit of 2.79 million metric tones (about 57%) of demand which is covered by importation despite increasing hectares of land put into production annually (<http://www.afriquejet.com/news/africa-news/agriculture:-nigeria-2010>).

According to Federal Ministry of Agriculture (1993), the annual supply of food crop including rice would have to increase at an annual rate of 5.9% to meet the food demand and reduce food importation significantly. The importation of rice has a negative effect on balance of payment as well as hinders the poverty reduction efforts of the government. The magnitude of the national demand and the need to conserve foreign exchange has led to the urgent need to address production constraints for increasing output to satisfy domestic consumption and even produce for export. This study, therefore, aims at examining the efficiency of resource-use among the different categories of irrigated rice farmers in Bade/Busari Local Government Area of Yobe State, Nigeria.

METHOD

This work is carried out in Yobe State. The State shares an international boundary with the republic of Niger to the North. Within the country, it shares borders with Borno to the East as well as Gombe to the South. The study population comprises all the irrigated farmers in Yobe State (small, medium and large scale farmers). Bade/Busari Local Government Area of Yobe State Along "River Yobe" was selected purposively for the study. The farm land for

rice production is divided in hectares by Lake Chad Basin Authority to the interested farmers. Farmers with 0.1 – 2 hectares of land are considered small scale farmers, those with 2.1 to 4 hectares are considered medium scale while those with more than 4 hectares are considered as large scale farmers. The respondents were selected using simple random sampling technique.

In each of the Local Government Areas, 128, 44 and 20 copies of structured questionnaire were distributed to the small scale farmers, medium scale farmers and large scale farmers respectively. A total of 384 irrigated rice farmers were used for the study. The sample chosen from each category of the category is based on the proportion of each category to the whole population. The theoretical basis of this study is anchored on Cobb-Douglas (CD) Production function, a mathematical relationship which describes the ways in which the quantity of an out depends on the quantity of inputs used. It expresses output as a function of variable inputs used given the quantities of fixed inputs which remain unchanged during a production period. The production function is given as:

$$X = A L^{b_1} K^{b_2} \dots\dots\dots 1$$

Where

- X = Total output
- L = Labour
- K = Capital
- b_1 and b_2 = substitution parameter
- $b_2 = (1 - b_1)$ and $(b_1 + b_2) = 1$

Linear Homogeneity of CD Production Function: If we increase each factor in equation (1) by a constant we have

$$Q = A (^L)^{b_1} (^K)^{b_2} \dots\dots\dots (2)$$

$$Q = A ^{b_1 + b_2} L^{b_1} K^{b_2} \dots\dots\dots (3)$$

Therefore, $^{\wedge} = 1$

From equation (3) we observe that the CD production is linearly homogenous in labour and capital. This implies that, if we increase all inputs by constant multiple ($^{\wedge}$), output will increase by the same constant.

Data were used for the study were drawn from both primary and secondary sources. The primary data were generated through the use of structured questionnaire that were distributed to the irrigated rice farmers in the study area. Inputs and output prices were taken based on the prevailing market prices in the study area during the production period. These were drawn from the market records (secondary data). This study made use of Stochastic Frontier production function: which comprise a production function

of the usual regression type with a composite disturbance term equal to the sum of the two error components (Meeusen and Van Broeck, 1997). The stochastic frontier production function is given as:

$$L_n(Y_i) = \beta_0 + \beta_1 L_n X_{1,ij} + \beta_2 L_n X_{2,ij} + \beta_3 L_n X_{3,ij} + \beta_4 L_n X_{4,ij} + \beta_5 L_n X_{5,ij} + V_{ij} - U_{ij}$$

Where

Y_i	=	Output of rice in (kg)
x_1	=	Farm size in (ha)
x_2	=	Quantity of seed in (kg)
x_3	=	Quantity of Fertilizer in (kg)
x_4	=	Quantity of Herbicides (Its)
x_5	=	Amount of labour used (Man – days)
V	=	Random variability in the production that can not be influenced by the farmer
U	=	Deviation from maximum potential output attributed to technical inefficiency
β_0	=	Intercept
β_1	=	Vector of production function to be estimated
i	=	1, 2, 3..... farmers
j	=	1, 2, 3..... inputs of the technical inefficiency

It is assumed that effects are independently distributed and U_{ij} arises by truncation (at zero) of the normal distribution with mean U_{ij} and variance $\sigma^2 U$. The β co-efficient are unknown parameters to be estimated along with the variance parameters Y . The β and Y_i coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumption made on the distribution form of the error term. The β indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term. Y indicates the dominant sources of random errors.

Efficiency Ratio: The efficiency of resource used will be determined by computing the ratio between Marginal Value Product (MVP) and the Marginal Factor Cost (MFC) of the variable inputs used in the production. The ratio for determining the relative efficiency of resource was calculated as:

r	=	
a.	if $r = 1$	resource is efficiently utilized
b.	if $r < 1$,	resource in question was over utilized.
c.	if $r > 1$,	resource is under utilized .

Elasticity of Production: The elasticity of production is the percentage change in output in relation to the percentage change in input which will be used to calculate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of input (Farrel, 1957). Return to Scale (RTS) is the summation of the entire production coefficient.

$$\begin{aligned}
 EP &= MPP/APP \\
 \text{if } RTS &= 1, \text{ constant return to scale} \\
 \text{if } RTS < &1, \text{ decreasing return to scale} \\
 \text{if } RTS > &1, \text{ increasing return to scale}
 \end{aligned}$$

RESULTS AND DISCUSSION

Table 1 reveals that all the estimated co-efficients associated with small scale farmers carried the expected positive sign, which indicates that an increase in the quality of each of the input would lead to increase in the output of rice. Out of the 5 independent variables used, the co-efficient of seed x_2 and fertilizer x_3 are significant at 1% and 10% level of probability respectively. Table 1 also reveals that the coefficient of all the inputs used by the medium scale farmers carried the expected positive sign. The coefficient of farm size though positive is also not significant at all levels tested. The coefficient of fertilizer (0.5507) and seed x_2 (0.0565) are significant at 10% level while that of herbicide (0.0939) and labour (0.2118) are significant at 5% level.

The estimated coefficient for all the inputs used among the large scale farmers except the farm size (-0.9319) are positive and conform to a priori expectation. The coefficient of fertilizer (0.4597) and herbicide (0.0971) are significant at 5% level. Given the specification of the stochastic frontiers function, the technical efficiencies of the irrigated rice farmers among the three categories of farmers are predicted, these are shown in table 2. The technical efficiency rating in table 2 reveals that the mean technical efficiency are 0.73, 0.83 and 0.86 for small, medium and large scale farmers respectively. This means that on the average, outputs fall by 27%, 17%, and 14% for small, medium and large scale irrigated rice farmers respectively from the maximum possible level due to inefficiency. In order to test the efficiency, the ratio of marginal value product (MPV) to the Marginal Factor Cost (MFC) for each input is computed and tested for its equality to I. The results in table 3 indicate that all the resources were inefficiently utilized as the marginal value products for farm size (x_1), seed (x_2), fertilizer (x_3) and herbicide (x_4) were greater than their respective factor prices for small, medium and large scale farmers while that of labour is lesser for all categories of farmers. The allocation efficiency indices of the resource ($AE1 > 1$) for x_2, x_3, x_4 for all categories of farmers indicate that

resources were under utilized. The AEI for labour ($AEI < 1$) indicates that labour was over utilized in the study area. The elasticity of production with respect to the inputs uses 0.2086, 0.2731, 0.4897, 0.0851, 0.0472 for farm size, seed, fertilizer, herbicide and labour respectively for small scale farmers while the elasticity for medium scale farmers were 0.0943, 0.0565, 0.5507, 0.0939, 0.2188 for farm size, seed, fertilizer, herbicide and labour are -0.9319, 0.3335, 0.4597, 0.0971 and 0.1738 respectively. The sums of partial elasticity are 1.1037, 1.0142 and 1.0106 for small, medium and large scale farmers. This shows that the farmers were operating at the region of increasing returns to scales which suggests that they are stills in stage one of the production process. Large scale farmers were closer to the rational stage (stage two) of production process than the other categories.

Table 1: Maximum likelihood estimates of the stochastic frontier function and Technical Efficiency

Parameter		Coefficient			Standard Error			T-Statistics		
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Constant	β_0	1.6650**	1.5073***	1.1921**	0.3448	0.2166	0.6556	4.8283	6.6959	2.9300
Farm Size	β_1	0.2086	0.0943	-0.9319*	0.1781	0.1889	0.5506	1.1172	0.4997	-1.6926
Seed	β_2	0.2731*	-0.0565	0.3335	0.1521	0.1070	0.2114	1.795	-0.5290	1.5775
Fertilizer	β_3	0.4897***	0.5507***	0.4597**	0.0657	0.1037	0.2265	0.7827	3.3105	0.4285
Herbicide	β_4	0.0185	0.0939**	0.9710**	0.235	0.0284	0.2265	0.7827	3.3105	0.4285
Labour	β_5	0.0472	0.2188**	0.1783	0.0822	0.0588	0.1121	0.5749	3.6000	1.5493

Source: Stochastic frontier result of output-input relation 2013

*= significant at 1% level, ** = significant at 5% level, *** significant at 10% level

	Small	Medium	Large
Gama(Y)	0.3743	0.9999	0.7594
Log likelihood	0.020	0.03594	0.0499

Table 2: Average Distribution of technical rating among rice producers in Bade/Bushari local govt. area of Yobe State

	Small	Medium	Large
Minimum value	0.51	0.543	0.52
Maximum value	0.97	0.998	0.98
Mean value	0.73	0.83	0.86

Source: Stochastic frontier result of technical rating 2013

Table 3: Estimates of Allocation Efficiency for Rice Inputs

Variables	Elasticity	Mean	MPP	MVP=MPPPy	MFC(P)	$AEI = \frac{MVP}{MFC}$
<i>Small scale farmer</i>						
Farm size	0.2086	1532,13	-	-	-	-
Seed	0.2731	41.78	9.90	544.50	60	9.075
Fertilizer	0.4897	207.91	3.61	198.55	80	2.482
Herbicide	0.0851	1.72	75.80	4169	1000	4.169
Labour	0.0472	1376	0.56	30.8	350	0.088
Total	1.1037					
<i>Medium scale</i>						
Farm size	0.0943	1681.13	-	-	-	-
Seed	0.0565	28.15	3.58	196.90	60	3.282
Fertilizer	0.5507	253.64	3.65	200.75	80	2.509
Herbicide	0.0939	2.11	71.71	3944.50	1000	3.944
Labour	0.2188	129.59	0.21	11.55	350	0.033
Total	1.0142					
<i>Large scale</i>						
Farm size	-0.9319	1806.45	-	-	-	-
Seed	0.3335	22.10	26.97	1483.35	60	24.723
Fertilizer	0.4597	271.43	2.26	124.30	80	1.554
Herbicide	0.9710	3.47	52.06	2863.30	1000	2.863
Labour	0.1783	101.00	3.04	167.2	350	0.478
Total	1.0106					

Source: Computed from lead equation

CONCLUSION AND RECOMMENDATIONS

The production function analysis revealed that there was under utilization of seed, fertilizer and herbicide for all categories of farmers while labour was under utilized. Comparison of allocative efficiency of resource used base on the ratio of MVP to MFC indicates that the large scale irrigated rice farmers were closer to the second stage of production which is the rational stage of production. The technical efficiency revealed that on the average the fall in output of the large scale irrigated rice farmers from the maximum possible level due to inefficiency is less than that of other categories. It is therefore recommended that small and medium irrigated rice farmers should pool their resources (among and inputs) together to derive the economies of large scale production. In addition, farm inputs such as seed, fertilizer in the study area should be made available to them by the government at subsidized rates to encourage them expand the scale of production, thereby boosting increased rice production.

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