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RESEARCH ARTICLE

Analysis of Technical Efficiency of Rice Farm in Nasarawa State, Nigeria

Rahman SA, EG Onuk and SO Oyewole*

Department of Agricultural Economics and Extension, Nasarawa State University, Keffi, PMB 135, Shabu-Lafia

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***Corresponding Address:**
SO Oyewole
shola4delord@yahoo.com

ABSTRACT

This study examined technical efficiency of rice farms in Nasarawa State. Primary data were obtained from 150 rice farmers with the aid of structured questionnaire. Stochastic frontier production function was used in analysing the data. It was revealed that the values of the gamma statistics 90, 92, 40 and 82% for Nasarawa south, north, west and all zones respectively are attributable to farmers' inefficiency factors which showed that technical inefficiency effects were present in rice production in Nasarawa State. The major input variables influencing rice output in Nasarawa State were farm size, seed, labour and agro-chemicals. The results further revealed that the average technical efficiencies for Nasarawa south, north, west and all zone were 66, 60, 79 and 62, respectively while the determinants of technical inefficiency were age, education and extension contact. The study recommends that Rice farmers in Nasarawa State be encouraged to increase the use of variable inputs at optimal level since the variable inputs had positive and significant relationship with rice output.

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INTRODUCTION

Rice is the third most frequently consumed crop in Nigerian households, but is the sixth most important contributor to daily per capita consumption of food in West Africa Sub-region (FAOSTAT, 2003). Rice is widely grown in Nigeria therefore it serves as source of food and income for both rural and urban dwellers. It is one of the crops that received priority research attention possibly due to its increasing importance as a food crop produced mostly in Nigeria and consumed nationwide (Tanko*et al*., 2012). Rice is an important crop that contributes to sustainable food security among households.

The production and consumption levels of rice in the sub-Saharan Africa remain substantial. Nigeria is the largest producer of rice in West Africa but still relies on massive rice importation. Nigeria accounts for 20% of sub-Saharan rice imports, mainly high quality parboiled rice from India and Thailand (Oladapo, 2003). According to Ajayi (2003), rice consumption in Nigeria has risen tremendously since the mid1970's at about 10% per annum due to consumer preference and making imports an inevitable option which stands at about 1,000 metric tonnes of rice. He further posited that the imports are procured from the world market, with Nigeria spending over $300 million on rice imports alone annually.

The demand for rice in Nigeria has been increasing at a much faster rate than in any other African country since the mid-1970s (Daramola, 2005). In a bid to address the demand/supply gap, governments have at various times come up with policies and programmers. It is observed that these policies have not been consistent. The erratic policies reflect the dilemma of securing cheap rice for consumers and a fair price for the producers. Thus, the fluctuations in policy and the limited capacity of the Nigerian rice sector to match domestic demand have raised a number of pertinent questions both in policy circles and among researchers. For example, what are the factors explaining why domestic rice production lags behind the demand for the commodity in Nigeria? Central to this explanation is the issue of efficiency of the rice farmers in the use of resources (PCU, 2002).

Due to increasing domestic demand for rice, Nigeria needs to expand her rice production capacity to meet the demand. This can be achieved by encouraging farmers to adopt the use of improved varieties and farmers should have good knowledge of rice agronomy (Ekeleme *et al.*, 2008). An underlying premise behind much of the research in efficiency is that farmers are not making efficient use of existing technology, hence efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 1985). Both production and consumption of rice in

Nigeria have vastly increased, but the production increase is insufficient to match the consumption increase (Lancon *et al.,* 2003). Therefore, there is need to investigate the efficiency of rice farms particularly in Nasarawa State which is one of the rice producing zone in Nigeria to ascertain if rice farmers are getting maximum return from the resources committed to the production of rice.

MATERIALS AND METHODS

The study area was conducted in Nasarawa State, Nigeria. The area is located in the middle-belt region between latitude 7^0 and 9^0 North and longitude 7^0 and 1^0 East. It lies within the Guinea Savanna region and has tropical climate. It has a moderate rainfall with a mean annual rainfall of 1311.75 cm. The state is made up of plain lands and hills measuring to 300ft above sea-level at some points. Agriculture is the dominant source of livelihood. Mixed farming is widely practiced. The state is well suited for production of a wide variety of crops such as yam, cassava, rice, guinea corn, maize, millet, cowpea, tomato, groundnuts, oranges and bananas.

The sampling frame for this study comprised of all the rice farmers in Nasarawa state. The data used for the study were mainly from primary sources who were collected from rice farmer's selected using stratified sampling procedure. The three agricultural zones in the state namely Southern, Western and Northern agricultural zones were considered for the study. The first stage involved random selection of three local government Areas from each zone as follows: Obi, Awe and Doma were selected from the southern zone, Toto, Kokona and Karu were selected from the western zone and Nasarawa-Eggon, Akwanga and Wamba were selected from the Northern zone. For the second stage, two villages were randomly selected from each of the LGAs giving a total of eighteen (18) villages. The third stage involved random selection of fifty (50) rice farm households from each of the three senatorial zones which cut across the selected villages giving a total of one hundred and fifty (150) rice farmers for the study. The stochastic frontier production function was used to obtain the parameters for the measurement of the technical efficiency.

The Cobb-Douglas production function used in this study was specified as:

$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} \ldots X_5^{\beta_5} e^{(v-u)}$ ---------- (1)

A logarithmic transformation provides a model which is li near in the log of the inputs and
hence, easily used for econometric estimation. A modified Cobb-Douglas production function for this study is defined following the specification of Coelli (1995) as;

$\text{Log } Y=\beta_o+\beta_1 \log X_1+\beta_2 \log X_2+\beta_3 \log X_3+\beta_4 \log X_4+\beta_5 \log X_5 +V_i - U_i$ ---------- (2) Where:

Log = the natural logarithm
Y_i= Output of rice in kilogram,
X_{1i}= Total land area under rice production in hectares,
X_{2i}= Seed quantity in Kilogram
X_{3i}= Labour used in mandays,
X_{4i}= Fertilizer used in kilogram,
X_{5i}=, Agro-chemical used in kilogram
β_i - β_5 = Regression coefficients,
β_o= constant,
i=1, 2, 3……150
V_i = random variable in production that cannot be influenced by the farmers,
U_i = Deviation from maximum potential output attributable to technical inefficiency.
The determinants of technical inefficiency (μ_i), is defined by

$\mu=\delta_0 + \delta_1 X_1 + \delta_2 X_2 + \delta_3 X_3 + \delta_4 X_4 + \delta_5 X_5 + \delta_6 X_6$ ------ (3)

Where:
δ_1-δ_6 are parameters to be estimated and X_1- X_6 are farmer-specific variables. These variables are included in the model to evaluate their possible influence on the technical efficiency of rice farmers. The δ_0 and δ_1- δ_6 are unknown parameters to be estimated along with the variance parameters $\delta^2$and γ. The variance of the random error $\delta v^2$and that of the inefficiency effect δu^2 and the overall variance of the model are related as follows.

$$\delta^2 = \delta v^2 + \delta u^2 \text{ ---------- (4)}$$

$$\gamma = \delta u^2 / \delta^2 \text{ ---------- (6)}$$

RESULTS AND DISCUSSION

Maximum Likelihood Estimation of Stochastic Frontier Production Function

The results of Maximum Likelihood Estimates (MLE) for the production frontier are presented in Table 1. The estimated parameters of sigma-squared are 0.67, 0.27, 0.99 and 2.31 for Nasarawa south, north, west and all zones respectively. These values were significantly different from zero at 5% indicating a good fit and the correctness of the specified distributional assumption of the composite error term. The generalized likelihood ratio statistics were 32.07, 20.18, 15.13 and 72.69 for Nasarawa south, north, west and all zones respectively. This ratio exceeds the critical chi-square values at 1% level of significance. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation is an adequate representation of the data. The values of the gamma statistics 0.90, 0.92, 0.40 and 0.82 for Nasarawa south, north, west and all zones respectively are attributable to farmers' inefficiency factors. The result revealed that technical inefficiency effects were present in rice production in Nasarawa State. The estimated parameter for land was positive and significant only in Nasarawa South senatorial zone. This implies that increase in land would increase the output of rice in this area. Seed was positive and significant for Nasarawa north and Nasarawa west. This result confirms the importance of seed in rice production in the area. The positive coefficients implied that rice output would increase with increase in the quantity of seed. The estimated coefficients of labour were significant in all the area except Nasarawa North. However, in Nasarawa west the estimated parameter showed a negative relationship with rice production which implied that rice output would decrease if farmers in this area increase the use of labour inputs. This may be due to farmers' accessibility to family labour. Fertilizer and chemical were significant and positive only in Nasarawa North. This could be that the soil nutrient is adequate enough to support rice production in other zones or farmers do not have adequate access to fertilizer.

Table 1: Maximum Likelihood Estimation Results of Stochastic Frontier Production for Rice Farms in Nasarawa State

Zone	Regression Coefficients				Variance Parameters			
	Land	Seed	Labour	Fertilizer	Chemical	σ^2	Γ	LR test
Nasarawa South	0.082* (3.805)	0.103 (0.057)	0.350* (3.352)	0.019 (0.718)	0.117 (1.097)	0.67 (17.68)	0.90 (11.17*)	32.07*
Nasarawa North	0.186 (1.078)	0.474* (9.048)	0.156 (1.525)	0.076* (3.186)	0.474* (4.824)	0.271* (1.97)	0.92* (9.34)	20.38*
Nasarawa West	0.268 (1.453)	0.938* (14.32)	-0.159* (-2.227)	0.026 (0.225)	0.849 (1.403)	0.99 (10.17)	0.402 (0.13)	15.13*
All zones	0.536 (0.460)	0.066 (0.949)	0.291* (3.270)	0.459 (1.840)	0.459* (4.987)	2.31* 3.98	0.823* 12.93	72.69*

Figures in Parentheses are t-ratios; *Significant at 5 percent level of probability; $\sigma^2 = \sigma_v^2 + \sigma_u^2$, $\gamma = \sigma_u^2 / \sigma^2$

Table 2: Socio-economic factors influencing inefficiency in the estimated stochastic frontier production function for rice farm in Nasarawa State

Zone	Regression coefficients					
	Age	Education	Household size	Farming Experience	Non-farm Income	Extension Contact
Nasarawa South	-0.172* (-4.582)	-0.637* (-10.778)	-0.099 (-1.151)	-0.067 (-1.033)	-0.386* (-8.781)	0.0164 (1.204)
Nasarawa North	-0.030 (-1.234)	-0.071* (-1.967)	-0.299* (-9.370)	-0.222 (-0.110)	-0.157 (-1.520)	-0.403* (-3.560)
Nasarawa West	0.005 (0.237)	0.016 (0.394)	0.004 (0.260)	0.002 (0.081)	-0.143* (-5.957)	-0.225* (-6.889)
All zones	-0.079* (-2.383)	-0.217* (-3.162).	-0.205* (-2.505)	-0.089* (-2.375)	-0.693* (-2.712)	0.041 (0.589)

Figures in Parentheses are t-ratios; *Significant at 5 percent level of probability

Table 3: Technical Efficiency of Rice Farms in NasarawaState

Zone	Technical Efficiency (%)		
	Minimum	Maximum	Average
Nasarawa South	0.11	0.96	66
Nasarawa North	0.15	0.95	60
Nasarawa West	0.10	0.92	79
All zones	0.10	0.99	62

Socio-economic factors influencing technical inefficiency in rice production

The results in Table 2 present the determinants of technical inefficiency of rice production in Nasarawa State. The results showed that age was negative and significant at 5% level for Nasarawa south and combination of all the zones. This implied that as farmers advance in age the technical inefficiency would reduce. Age is very important in crop production in correlation with farming experience which has a significant influence on the decision making process of farmers with respect to risk aversion, adoption of improved agricultural technologies, and other production-related decisions.

The estimated parameter obtained for education showed a significant and negative relationship with technical inefficiency for all the zones except Nasarawa west which is an implication that as years of education increases farmers' technical inefficiency reduces. Educational attainment is very important because it could lead to awareness of the possible advantages of modern farming techniques. Educated farmers are able to gather, understand and use information from research and extension more easily than illiterate farmers. Moreover, educated farmers are likely to be less risk-averse and therefore more willing to try out modern technologies.

The estimated parameter obtained for household size showed a negative relationship with technical inefficiency for Nasarawa north and the combination of all the zones. This implied that farmers who have large household sizes are more technically efficient. The reason for this relationship is that as the number of people in a household increases, a pool of family labour becomes available and this leads to specialization.

Non-farm income was found as factor of technical inefficiency in Nasarawa north and west. This variable exerts negative influence on technical inefficiency which implied that increase in non-farm income would reduce technical inefficiency. The coefficients of extension contact were negative and significantly related to technical inefficiency for all the zones except Nasarawa west. This implied that contact with extension agents reduces technical inefficiency. Extension contact may enhance farmers' accessibility to information on improved farm technologies which in turn can improve farmer's productivity. Non-significance of extension in Nasarawa west may be due to limited access of farmers to extension agents in the area.

Technical Efficiency of Rice Farms in Nasarawa State

Table 3 showed the average technical, efficiency of rice farms in Nasarawa state. The results showed that the average technical efficiency for Nasarawa south, north, west and all zones were 66, 60, 79 and 62 respectively. The implication of the result is that the average rice farmer in Nasarawa north requires 19%, that is, {1-(0.60/0.79) x 100} cost savings to attain the status of the farmers in Nasarawa west. Rice farmers in Nasarawa south would also need 13% cost savings which is {1-(0.66/0.79 x 100} to become efficient like farmers in Nasarawa west. The fact that the technical efficiency of all sampled rice farmers is less than 1 implies that no farmer reached the production frontier. These results implied that there was opportunity for increasing farmers' productivity and income in all the zones through increased technical efficiency with the use of existing farm resources.

Conclusion and recommendations

The results from the production and cost functions showed that the major input variables influencing rice output in Nasarawa State were farm size, seed, labour and agro-chemicals. These results imply that in order to improve output levels in rice production there is need to increase farm size, seed, labour and quantity of agro-chemical used in production of rice. The estimated mean values of technical inefficiency in rice production suggest that some scope exist for farmers to increase their levels of technical efficiency by allocating the existing resources more optimally.

This study therefore, recommends that:

a) Rice farmers in Nasarawa State should be enlightened on how to use variable inputs at optimal level since the variable inputs had positive and significant relationship with rice output.

Effective extension services and enabling environment should be created to promote transfer and adoption of improved technologies among rice farmers.

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