

ANALYSIS OF TECHNICAL EFFICIENCY AMONG RAINFED RICE FARMERS: CASE STUDY OF ARDO-KOLA AND JALINGO LOCAL GOVERNMENT AREAS OF TARABA STATE, NIGERIA

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ABSTRACT

The study analyzed technical efficiency among rainfed rice farmers in Ardo-kola and Jalingo local government area of Taraba State, Nigeria. The objectives of the study were to estimate the technical efficiency and factors influencing technical efficiency of rice farmers in the study area. A total of 180 rice farmers were sampled through purposive and simple random sampling techniques using structured questionnaire. Descriptive statistics and stochastic frontier approach were used to analyze data collected. Results of the analysis revealed that basic production variables showed a positive relationship with output except fertilizer. The study also revealed that age, education and farming experience increases technical efficiency of rice farmers in the study area. The mean of technical efficiency of 0.75 showed that there is still possibilities of increasing the technical efficiency of rice farmers if certain corrective measures are taken as inefficiency still existed in the study area. The study recommends intensive agricultural extension efforts to rice farmers.

Keywords: Technical efficiency, Rainfed, Stochastic Frontier Approach, Taraba State, Rice Production

INTRODUCTION

Agriculture accounts for over 70 percent of the active labor force, and more than 23 percent of the Gross Domestic Product in Nigeria (World Bank, 2007). Agriculture is the mainstay of the majority of Nigerian rural poor, producing major food crops comprising cereals such as sorghum, maize, rice; tubers such as yams, cassava, legume such as groundnut and cowpea as well as vegetables. Rice, maize and wheat make up two-third of this already small group of foods. These three grains are the staple food for more than four billion people both as a source of nutrition and income. Staples dominates the major part of our energy and nutrient need. However, if staple crops are threatened by drought, pests or nutrients-poor soils, hunger and poverty can rise dramatically (International Atomic Energy Agency, Bulletin, 2012). Rice (*Oryza sativa*) is gradually taking the lead in terms of economic importance as it is consumed

by more than 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, over 40 million people in Africa and over 150.3 million people in America (Biya, 2005).

Rice production and consumption are of global importance providing more than 20.0% of caloric needs of millions of people on daily basis (Yang and Zhang, 2010). However, an average Nigerian now consumes 24.8 kg of rice per year, representing 9% of total caloric intake. (Ugwanyi C.A *et al.*, 2008). Although Nigeria is the largest producer of rice in West Africa yet it accounts for 20% of sub-Saharan African rice import (Yisa E. A *et al.*, 2010). In Nigeria, the agricultural sub-sector parades a large array of staple crops made possible by the diversity of agro-ecological production system, out of these staple crops, rice has risen to a position of preeminence. Rice production occurs in all agro-ecological zones in

Nigeria with the middle belt enjoying a comparative advantage in production over the other parts of the country. Production is primarily by small-scale producers, with average farm size of 1-2 hectares. Yield per hectare is low due to production systems, aging farming population and low competitiveness with imported rice. Rice growing environment in Nigeria are usually classified into five ecosystems namely: Rain-fed upland, Rain-fed lowland, Irrigated lowland, Deepwater and Mangrove swamp (Biyi, 2005).

The country is the highest producer and consumer of rice in the West African sub-region, the total paddy rice production in Nigeria stood at about 4.0 million metric tons representing about 44% of the total production in the West African sub-region (FAOSTAT, 2008). Even though, rice production in Nigeria has boomed over the years, there has been a considerable lag between supply and demand levels with imports making for the shortfall. This supply-demand gap kept widening due to increasing population growth and shift in consumers preference towards rice (Achike and Okoye, 2004; Ugwuanyi, et al. 2008). Others identified by (Ahmadu and Ehrabor, 2012) include low hectareage under cultivation and inefficiency of the farmers in the use of production resources.

Thus, according to Okuruwa *et al.* (2009), the issue of efficiency of the rice farmers in the use of resources is central to explaining why domestic rice production lags behind the demand for the commodity in Nigeria. Since increased productivity is directly related to production efficiency, it is very important to raise productivity of the farmers through government intervention of the provision of active extension agents, delivery of improved seeds varieties, and prompt delivery of fertilizer to farmers, provision of credits facilities among others.

Since agriculture contributes the largest share to foreign exchange earnings and leads the livelihood of a large proportion of the population, improving the production and productivity of this sector is the best way to bring about reduced poverty and to achieve food security (Asfaw and Bekele, 2010). Increasing production and productivity is also critical to economic growth and the development of the country in general and that of the study area in particular. However, given limited agricultural resources like arable

land, it will be a difficult job to increase production and productivity. Thus, this situation calls for improving yields of major staple crops such as rice for better food security. One way to bring about increased agricultural production and productivity is the introduction of improved technology and agricultural research (Asfaw and Bekele, 2010). Despite the fact that this policy has been pursued for a long time ago, improvement in agricultural productivity in general and rice productivity in particular has been minimal. This negligible outcome might be due to the difficulty for agricultural researchers to identify when and how new technologies were used by farmers and the inability to finance farm technologies and other farm expenditures owing to the low per capita income of farmers and high prices of those technologies. According to Asefa (2012), if existing inputs and technologies are not efficiently utilized, trying to introduce new technologies will not be cost-effective. That is, under such circumstances, the use of the existing technologies is more cost-effective than applying new technologies. Thus, a technical-efficiency analysis is crucial to find out if farmers are efficient in the use of the existing resources and to decide when to introduce new technologies. This study, therefore estimated technical efficiency of rainfed rice farmers in the study area

METHODOLOGY

Study Area

The study was conducted in Ardo-Kola and Jalingo Local Government Areas of Taraba State, Nigeria. The state lies between latitudes 6° 30' and 9° 36' North of the equator and between longitudes 9° 10' and 11° 50' East of the Greenwich meridian (Taraba State Diary, 1999). The state has a land area of 59,400 km² with a population of 2,300,736 people (Federal Republic of Nigeria Official Gazette, 2009). It shares a common boundary with Bauchi State in the north and Gombe State in the north east, Adamawa State in the east and Plateau State in the North West. It is further bounded to the West by both Nasarawa and Benue states, while it shares an international boundary with the republic of Cameroun to the south and south east (Taraba State Diary, 1999).

The state is predominantly agrarian in nature, with majority (80%) of its inhabitants

depending on subsistence agricultural practices mainly in food production cultivating crops such as maize, rice, yam, cassava, sorghum, groundnut and sugar cane. (Tijjani, 2010). The main vegetation cover of the state is the guinea savanna, the topography is essentially marked with mountainous land transverse by large river valley such as Benue, Taraba, Donga and Bibinu.

Sampling Techniques and Data Collection Method

This study adopted purposive and simple random sampling techniques, six clusters were purposively selected based on respondent's concentration. Subsequently, hundred and eighty (180) respondents were randomly selected and administered with structured questionnaire.

Table 1: List of Rice Registered Farmers in the Study Area

S/N	Local Government Areas	Rice Farmer Cluster	Membership	No. Of Farmers Selected
1	Ardo-Kola	Sunkani Rice Cluster	397	56
		Mayo-Ranewo Rice Cluster	152	22
		Jauro Yinu Rice Cluster	175	25
2	Jalingo	Koffai Rice Cluster	235	33
		Kona Rice Cluster	134	19
		Wuro Sembe Rice Cluster	176	25
Total			1269	180

Source: Taraba State Agricultural Development Programme (TADP), 2019

However, the selection of the farmers was based on this formula as adopted by Kehinde, *et al.* (2012): $n_1 = \frac{n}{N} \times N_1$ -----eqn. (1)

Where:

n_1 = number of farmers selected

n = sample size

N = total population of the rice farmers

$N_1, N_2, N_3, N_4, N_5, N_6$ = population of rice farmers in each cluster

Analytical Techniques

The Stochastic Production Function

A Cobb-Douglas functional form was employed to model rice production technology in the study area to estimate the rice production efficiency, based on the following reasons: (a) the functional form has been used in many empirical studies, particularly, those relating to developing country agriculture (Ajibefun, 2002; and Bravo-Ureta and Pinheiro, 1997); (b) the functional form also meets the requirement of being self-dual, that is, allowing an examination of farm efficiency. Also, descriptive statistic such as frequency and percentage were adopted.

The Cobb-Douglas functional form for the rice farms in the study area is specified as follows for the production functions:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + V_i - U \quad \text{eqn. (2)}$$

where;

Y_i = Output of rice (kg);

X_1 = Farm Size in hectares

X_2 = Family labour (mandays)

X_3 = Hired labour (mandays)

X_4 = Seed in kg

X_5 = Fertilizer in kg

X_6 = Agrochemicals in litres

V_i = Random variable which is assumed to be independently and identically distributed $N(0, \delta^2_{V_i})$ and independent of U ; U_i = Non-negative random variable associated with technical inefficiency in production, and is assumed to be independently and identically distributed $N(0, \delta^2_{U_i})$.

The inefficiency model is specified thus:

$$\mu = \delta_0 + \delta_1 W_1 + \delta_2 W_2 + \delta_3 W_3 + \delta_4 W_4 + \delta_5 W_5 + \delta_6 W_6 + \delta_7 W_7 \dots \text{eqn. (3)}$$

where;

μ = Technical inefficiency effect

δ = Parameters to be estimated

W_1 = Age of farmer in years

W_2 =Educational level of farmer (number of years spent in school)

W_3 =Household Size

W_4 = Years of Rice farming experience

W_5 =Extension contact (1 if the farmer has extension contact, 0 if otherwise)

W_6 = Access to credit (1 if farmer has access to credit, 0 if otherwise)

W_7 = Sex of farmer (1 if male, 0 if otherwise).

RESULTS AND DISCUSSION

Estimate of Stochastic Frontier Production Function

The Maximum Likelihood Estimate (MLE) of the Cobb-Douglas stochastic frontier production function as presented in Table 2 indicates the relative importance of factor inputs used in rice production in the study area. Other vital estimates include the sigma squared (σ^2), gamma (γ) and the log likelihood function. The sigma squared indicates the goodness of fit of the model, while gamma gives the proportion of the deviation of output from the production frontier. From the result, the coefficients of factor inputs have the expected positive sign except the coefficient of fertilizer input (β_5) which has a negative sign. The coefficient of seed (β_4) appears to be the most important factor of production with an elasticity of 0.155. The coefficient is positive and significant at 1% level, this confirms to *a priori* expectation. The elasticity of 0.155 suggest that a unit increase in the quantity of seed will result in 0.155% increase in rice output. The coefficient of agrochemical (β_6) is the second most important factor with an elasticity of 0.128 and statistically significant at 5%. This implies that agrochemical is also an important significant factor which influences change in the output of rice production in the study area. Thus, a unit increase in the use of agrochemical will result in 0.128% increase in the yield of rice production in the study area. The predicted coefficient of hired labour (β_3) is estimated to be 0.113 and is positive and statistically significant at 5% level. This suggest that hired labour is a significant factor that influences changes in the output of rice, such that a unit increase in hired labour significantly contribute to the output of rice. The coefficient of farm size (β_1) was estimated to be 0.101 and statistically significant at 1%. The implication is that farm size is also an important factor which influences rice production. Thus a unit increase in farm size will result to 0.101% increase in output. Family labour (β_2) was estimated to be 0.006 and not significant even at 10% level. However, the coefficient of fertilizer (β_5) was estimated to be negative and not significant.

Diagnostic statistics as revealed by the analysis revealed that gamma (γ) also known as the variance ratio was estimated to be 0.835 and highly significant at 1% level, suggesting that

systematic influence which were unexplained by the production function were the main sources of random errors. This implies that about 84% of the variation in rice output is due to differences in technical efficiency among the farmers. Sigma squared (σ^2) was estimated to be 0.020 and highly significant at 1% level. This indicate a good fit and correctness of the specified distributional assumption of the model particularly about the error term. Thus, the result of the diagnostic statistics confirmed the relevance of stochastic frontier production using maximum likelihood estimates.

Analysis of the estimated coefficient of the technical inefficiency variables tells us the contribution of the variables to technical efficiency. The coefficient of age (δ_1) is estimated to be negative as it conforms to a priori expectation and significant at 5% level, indicating that age lead to or increase technical efficiencies of the rice farmers in the study area. This conforms to the findings of Ataboh *et al.* (2014) who reported that older rice farmers are more technically efficient than younger farmers. The implication is that increase in age of farmers increases their experience in acquiring and handling inputs thereby making them more efficient. The predicted coefficient of education (δ_2) was negative and it is in consonance with *a priori* expectation and statistically significant at 5% level. The possible explanation could be that farmers with greater years of formal schooling tends to be more technically efficient. This agrees with the findings of Shehu *et al.* (2007) who studied on analysis of technical efficiency of small scale rain-fed upland rice farmers in North-west Agricultural Zone of Adamawa State, Nigeria; and Amaza and Maurice (2005) who studied on identification of factors that influence technical efficiency in rice based production system in Nigeria. The implication is that with more years of formal education, new technologies could be better understood and adopted, which will subsequently make it possible to move close to the production frontier. The predicted coefficient of household size (δ_3) is predicted to be positive and not significant even at 10% level, this does not conform to a priori expectation. This is in conformity to the findings of Shehu *et al.* (2007). The estimated coefficient of farming experience (δ_4) is predicted to be

negative and statistically significant at 1% level. This shows that increase in experience in rice production would reduce technical inefficiency. The implication is that farmers' experience could be associated with skill accumulation which could enhance productivity and thereby reduce technical inefficiency. This also is in conformity with the findings of Binuyo *et al* (2016). The coefficient of the extension contact (δ_5) variable as an efficiency factor is estimated to be positive

and not statistically significant even at 10% level. The estimated coefficient of gender (δ_6) is negative and not significant even at 10% level. This could indicate that male dominated the rice farming enterprise in the study area as they are mostly household heads and also involved with strenuous activities, while the female counterparts handles food processing and marketing activities. This tends to decrease technical inefficiencies of the rice farmers.

Table 2: Maximum-likelihood Estimates of parameters in Cobb-Douglas Stochastic Frontier Production Function

Variable	Parameter	Coefficient	Standard Error	t-ratio
Production factors				
Constant	β_0	3.537	0.190	18.590***
Farm size (X_1)	β_1	0.101	0.031	3.217***
Family labour (X_2)	β_2	0.006	0.005	1.123
Hired labour (X_3)	β_3	0.113	0.052	2.173**
Seed (X_4)	β_4	0.155	0.059	2.607***
Fertilizer (X_5)	β_5	-0.078	0.053	-1.466
Agrochemicals (X_6)	β_6	0.128	0.054	2.383**
Inefficiency model				
Constant	δ_0			
Age (Z_1)	δ_1	-0.037	0.015	-2.514**
Education (Z_2)	δ_2	-0.125	0.061	-2.058**
Household size (Z_3)	δ_3	0.094	0.082	1.141
Farming experience (Z_4)	δ_4	-0.150	0.055	-2.711***
Extension contact (Z_5)	δ_5	0.049	0.070	0.704
Sex (Z_6)	δ_6	-0.051	0.067	-0.762
Diagnostic statistics				
Sigma squared	σ^2	0.020	0.003	6.920***
Gamma	γ	0.835	0.289	2.887***
Log likelihood function		125.16		
LR test		7.95		
Number of observations		180		

*** Significant at 1% level ** significant at 5% level . Source: Computed from Field Survey Data, 2018

Rice Farmers' Technical Efficiency

The predicted technical efficiencies of farmers ranged from 0.47-0.97 (Table 17). Majority (76.2%) of the farmers operated at a technical efficiency of between 0.67-0.97. On the average, a farmer operated at a technical efficiency 0.75. This implies that, if the average rice farmers in the area were to achieve the level of technical efficiency as shown by the most efficient farmer, then they would realize an increase in output of 25.77%, that is (1-0.75/0.97). Majority (51.5%) of the farmers were

found to be efficient below the mean value, while 47.9% were above the average technical efficiency. Hence, in the short run there is still scope of increasing the technical efficiency of rice farmers in Northern part of Taraba State through better use of available resources. This finding does not agree with Shehu and Mshelia (2007) who studied on productivity and technical efficiency of small-scale rice farmers in Adamawa State, Nigeria which revealed a mean technical efficiency of 0.96%, which ranged from 0.74 to 0.99.

Table 3: Frequency Distribution of the Technical Efficiencies of Rice Farmers in the Study Area

Ranges	Frequency	Percentage of farms
0.47- 0.51	4	2.2
0.52-0.56	14	7.8
0.57-0.61	10	5.5
0.62-0.66	15	8.3
0.67-0.71	27	15.0
0.72-0.76	24	13.3
0.77-0.81	23	12.8
0.82-0.86	26	14.5
0.87-0.91	22	12.2
0.92-0.96	14	7.7
0.97-1.00	1	0.6
Total	180	100
Mean efficiency	0.75	
Minimum efficiency	0.47	
Maximum efficiency	0.97	

Source: Field Survey, 2018

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The result of the Stochastic Frontier Approach revealed that basic production variables included in the production function had positive relationship with rice output except fertilizer. Variables such as age, education, farming experience and sex caused an increase in technical efficiency of the farmers in the study area. The mean of technical efficiency was 0.75, given the shortfall of 25% in the technical efficiencies of farmers, there is therefore potential to improve output of an average farm without the need for any change in existing technology. More agricultural extension efforts should be intensified to ensure timely dissemination of appropriate technology to rice farmers.

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