Research & Reviews

ISSN: 2319-9857

Research and Reviews: Journal of Agriculture and Allied Sciences

Technical Efficiency of Small-Scale Rice Farmers in Nigeria.

PO Erhabor and J Ahmadu*

Department of Agricultural Economics and Extension Services, Faculty of Agriculture, University of Benin, Benin City, Nigeria.

Research Article

Received: 01/06/2013
Revised: 05/06/2013
Accepted: 07/07/2013

***For Correspondence**

Department of Agricultural Economics and Extension Services, Faculty of Agriculture, University of Benin, Benin City, Nigeria.

Keywords: Technical, efficiency, rice, farmers, Nigeria

ABSTRACT

The study examined the technical efficiency of small-scale rice farmers in Nigeria. It focused specifically on the socio-economic characteristics of the rice farmers, production function for rice, level of technical efficiency of the farmers and their inefficiency parameters. Data used for the study were obtained using a well structured questionnaire. Out of the 300 rice farmers interviewed, a total of 263 respondents (130 and 133 for Niger and Taraba States respectively) provided useful data for analysis. Data analysis was done using descriptive statistics, stochastic frontier production function and inefficiency model. The results of the study showed that rice production in the study area was dominated by married (79%) males (92%) with average age of 45 years, family size of 10 persons and farming experience of about 17 years. Majority (62%) of the farmers had formal education and 65% of them had farming as their major occupation. The farmers had average farm size of 2.93 hectares and average yield of 2,424kg/ha. Furthermore, the results showed the significant presence of inefficiency parameters in the stochastic frontier production function evidenced by the log-likelihood ratio test (91.24) that was significant at 1%. Technical inefficiency accounted for 61% of the variation in output of the rice farmers. Average technical efficiency of the farmers was 0.61. Age of the farmers was positively and significantly related to their technical inefficiency; while household size, educational level, farming experience, rice variety and number of improved technologies adopted were negative and significant determinants of the farmers' inefficiency. It was stressed that the costs of major inputs for rice production should be subsidized and adequate provision made for the farmers to have easy access to them, including agricultural credit.

INTRODUCTION

Rice is one of the world's most important food crops, being the staple food for over 50% of the world population, comprising India, China and a number of other countries in Africa and South America [34](Okoruwa and Ogundele, 2004). It accounts for 21% of the world's total calorie intake (IRRI, 2004).

In Nigeria, rice has grown in importance, evolving from being reserved for ceremonial occasions to a major component of the nation's diets. It is now the fastest staple consumed and one of the most preferred food items for most urban dwellers [11]. Statistics show that the average share of total calories originating from rice for Nigeria is growing, increasing from 2% in 1970 to 9% in 2001; while this has fallen in Asia and has remained fairly constant in South America, United States and European countries [28]. Further, the per capita consumption of rice in Nigeria is increasing at a much faster rate than in other West African countries since the mid 1960s. For example, during the 1960s, Nigeria had the lowest per capita annual consumption of rice in the sub-region with an annual average of 3kg and this had grown significantly at 6.3% per annum. Consequently, per capita consumption during the 1980s averaged 18kg and reached 22kg in 1995 – 2000 [34]. The average Nigerian now consumes about 25kg of rice per annum [24,28]. These trends have meant that rice is no longer a luxury food in Nigeria and has become a major source of calories for the urban poor [7].

Globally, more than 95% of rice production comes from developing countries. In the last three decades, rice production has increased by 85%, with the highest increase observed in Africa [23]. In West Africa, Nigeria is the highest producer of the commodity, producing about 44% of the total production in the sub-region [22] with the central agro-ecological zone accounting for about 50% of the nation's production [33]. Since the 1960s, Nigeria rice production has grown at a faster rate (6.9% per annum) than in other West African countries (3.2% per annum) [34]. However, the increase in rice production could not meet the increase in demand. This is evidenced by the decline in rice self-sufficiency ratio from 99% in 1961 – 75 periods to 79% in 1995 – 2000 periods. The supply gap has often been filled with rice importation. For instance, rice imports in Nigeria increased from 345,500 metric tonnes in 1996 to 2,456,565 metric tonnes in 2003, being the largest importation in the West African sub-region [7,16]. In 2000 – 2001 periods, Nigeria was the leading importer of rice in the world and in 2002 Nigeria ranked second after Indonesia as the largest importer in the world [24].

In an effort to boost rice production in particular and agricultural production in general and provide adequate food for the rising Nigerian population, the Federal Government, over the years, formulated various agricultural policies and embarked on a number of intervention projects and programmes. Despite the various policy measures, domestic rice production has not increased sufficiently to meet the increased demand. Although Nigeria has comparative resource advantage, in terms of favourable climate, edaphic and ecological conditions with about 4.8 million hectares of potential land area for rice production [27] to be self-sufficient in the production of the commodity, the reverse is the case.

This pathetic situation has raised a number of pertinent questions. For instance, what is responsible for shortage of rice in Nigeria? Could it be that the rice farmers are not efficient in the use of resources? What is the level of technical efficiency of the farmers in rice production? It is with a view to respond to these questions that this study sought to examine the technical efficiency of small-scale rice farmers in Nigeria. The specific objectives of the study are: to examine the socio-economic characteristics of the small-scale rice farmers in Nigeria and their production inputs;

- Estimate the production function for rice in Nigeria;
- Determine the level of technical efficiency of the rice farmers; and
- Examine the determinants of the technical inefficiency of the farmers.

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Technical efficiency (TE) is defined as the measure of a firm's success in producing maximum output from a given set of inputs. On the contrary, technical inefficiency of a farm entails producing too little from a given bundle of inputs or the disproportionate and excessive usage of all inputs [35].

The level of TE of a particular firm in an industry is characterized by the relationship between observed production and some efficient production. The measurement of firm specific TE is based upon deviations of observed output from the best production or efficient production frontier. If a farmer's production point lies on the frontier, it is perfectly efficient. If it lies below the frontier then it is technically inefficient. The level of efficiency of the individual farmer is defined by the ratio of the actual production to the potential or efficient production. This comparison is made because, in practice, the production function of the fully efficient firm is not known and so must be estimated from observations on a sample of firms in the industry in question [15,34].

The methods of estimating the relative TE of farmers which is now commonly known as frontier production function began with Farrell's ideas [21]. The common feature of these estimation techniques is that information is extracted from extreme observations from a body of data to determine the best practice production frontier. From this, the relative measure of TE for the individual farmer can be derived [30,34]. The frontier approaches estimation techniques of relative TE of firms can be generally categorized into two; namely: Data Envelopment Analysis (DEA), a non-parametric mathematical programming approach to frontier estimation; and the stochastic frontiers which involve an econometric estimation [38]. Detailed discussions of the DEA methodology are presented by Farel *et al.* [20], Seiford and Thrall [38], and Ali and Seiford [9].

In this study, the stochastic frontier approach was adapted. This is because of the pit falls of the DEA. The DEA assumes that all deviations from the frontier are as the result of inefficiency in production. Thus, the measurement error and other noise not captured by the model may influence the shape and position of the frontier. This may also give misleading indications of relative managerial competence. In addition, one cannot test hypotheses regarding the existence of inefficiency in production in the DEA.

The stochastic frontier production function (SFPF) was independently proposed by Aigner *et al.* [4], and Meeusen and Van den Broeck [31] to estimate the TE of the firms. This function has two error components: the symmetric error term (V_i) which accounts for noise (factors beyond the control of the farmers in production such as weather, topography, disease outbreak, strike and government policy); and the non-negative asymmetric error (U_i) accounting for the technical inefficiency of the farmers in production. The V_i is assumed to be independent of U_i; identically and normally distributed with zero mean and constant variance {N~ (O, δ_v^2)}. The U_i is assumed to have a distribution that is either half normal, exponential or truncation of a normal distribution. If $U_i = 0$, no technical inefficiency occurs, the production lies on the stochastic frontier. If $U_i > 0$, production lies beneath the frontier and is said to be inefficient.

The stochastic frontier production models have been applied widely by many researchers to estimate the efficiency of agricultural production. In Japan, the mean TE of the average rice farm household was estimated to be about 75% [6]. In Nigeria, TE was estimated for food crop farmers in Kwara [2], Oyo [5], Imo [37], and Edo [19] States; Cotton farmers in the Northern Nigeria [10] and cocoa-based agro-forestry system in Oyo State [8]. The results indicated a wide variation in the TE of the farmers, ranging from 22 to over 90%. Ajibefun *et al* [5] observed that inefficiency of the farmers increased with age, farm size and ratio of hired labour to total labour, while the level of technical inefficiency declined with years of farming experience and level of education. Furthermore, technical efficiency differentials in rice production technologies (traditional and improved rice varieties) in Nigeria [34] indicated that the TE for the two groups of farmers ranged from about 50 to 90%. Average technical efficiency of 95% was reported for rice production under small-scale farmer-managed irrigation schemes and rainfed systems in Kogi State [36] and 65% for rainfed upland rice in the guinea savannah zone of Nigeria [39].

METHODOLOGY

The study was carried out in Nigeria. A multi-stage sampling technique was employed in this study. First, seven (7) major rice producing States of Nigeria were purposively selected. Each of these seven States produced at least 5% of the total rice produced in the country as follows: Niger State (14.90%), Benue (10.15%), Taraba (9.85%), Ebonyi (8.69%), Kaduna (5.44%), Borno (5%), and Kano (5%) [33]. Second, a random sampling technique was employed to select two (2) States (Niger and Taraba) from the seven States. The third stage was the purposive selection of all the Three (3) agro-ecological zones of the two States (Niger and Taraba North, Central and South agro-ecological zones respectively) mainly because rice production cuts across all the agro-ecological zones of the states. Fourth, a random sampling technique was applied to select one (1) Local Government Area (LGA) from each of the zones giving rise to six (6) LGAs. Fifth, a total of 12 villages (2 from each LGA) were randomly selected. The last stage of this procedure was the random selection of 25 respondents (rice-based farmers cutting across different production systems) from each village for inclusion in the sample, thus giving rise to a total of 300 respondents (150 respondents for each state). A total of 263 respondents (130 and 133 for Niger and Taraba states respectively) provided useful data for the analysis. The data were collected on 2008 production season.

Data were processed and data analysis was done using descriptive statistics (means, frequencies percentages and tables), stochastic frontier production function and inefficiency model.

Stochastic Frontier Production Function and Inefficiency Model

The stochastic production frontier using the Cobb-Douglas function adapted from Battese and Coelli [13] was used to determine the technical efficiency of the rice farmers. The model in log-linear form is explicitly expressed as:

$$\ln Y = b_o + b_1 \ln X_{1i} + b_2 \ln X_{2i} + b_3 \ln X_{3i} + b_4 \ln X_{4i} + b_5 \ln X_{5i} + b_6 \ln X_{6i} + (V_i - U_i) \ldots (1)$$

Where,

i		Stands for the ith farmer
Y	=	Output of rice (kg)
X_1	=	Farm size for rice (ha)
X_2	=	Family labour (mandays)
X_3	=	Hired labour (mandays)
X_4	=	Quantity of rice seed used (kg)
X_5	=	Quantity of fertilizer used (kg)
X_6	=	Quantity of herbicides used (litres)
V_i	=	Random (symmetric) error term accounting for deviation of output of rice from the frontier caused by "noise"
U_i	=	Non-negative (asymmetric) random error term accounting for the technical inefficiency in production.
In	=	Natural logarithm
$b_o, b_1, \ldots b_6$	=	Unknown parameters to be estimated

Other parameters estimated include sigma squared (δ_s^2), gamma (γ) and the likelihood ratio (LR) test. The δ_s^2 indicates the goodness of fit of the model used and the correctness of the distributional assumptions underlying the composite error terms (V_i and U_i). It is expressed as:

$$\delta_s^2 = \delta_v^2 + \delta_u^2 \qquad (2)$$

Where,

δ_v^2 = Variance of the error term due to noise;
δ_u^2 =Variance of the error term resulting from inefficiency in production.

The gamma (γ) gives the proportion of the deviations of rice output from the frontier due to technical inefficiency. It is given as:

$$\gamma = \delta^2_u/\delta_s^2 \quad (3)$$

$O \leq \gamma \leq 1$

Where,

δ_u^2 and δ_s^2 are the variance of the error term resulting from inefficiency in production and sigma squared respectively.

If γ = 0, it means all deviations from the frontier are due entirely to noise. If γ = 1, it implies that all deviations are due to technical inefficiency.

The likelihood Ratio (LR) is used to test for the significant presence of inefficiency in the stochastic frontier production function. If the random variable, U_i is absent from the model (ie γ = 0), then the OLS function is adequate representation of the data. The LR test of one-sided error used in this analysis is given as:

$$LR = -2[\log (Lo) - \log (L_1) \quad (4)$$

Where,

Log (Lo) = Log-likelihood value under the OLS function (the null hypothesis)
Log (L_1) = Log-likelihood value under the maximum likelihood estimates (the alternative hypothesis).

The firm specific measure of technical inefficiency is determined from the conditional expectation of U_i given ϵ_i as demonstrated by Jondrow *et al.* [29] quoted in Bravo-Ureta and Rieger [14]; Zaibet and Dharmapala [40]; and Ehirim and Korie [17]. This is mathematically expressed as:

$$E (U_i /\varepsilon_i) = \frac{\delta_v\delta_u}{\delta_s} \left(\frac{F^* (\varepsilon_i \lambda /\delta_s)}{1 - F^* (\varepsilon_i \lambda /\delta_s)} \right) - \frac{\varepsilon_i\lambda}{\delta_s}, \qquad I = , 2, ...n \qquad (5)$$

Where: F^* is the density function of a standard normal random variable evaluated at $\epsilon_i\lambda/\delta_s$, and

$\epsilon_i = V_i - U_i$.

The technical efficiency of the ith farmer is then given as:

$$TE_1 = \frac{Y_i}{Y_i^*} = \frac{\exp[X_i\beta + (V_i - U_i)}{\exp X_i\beta + V_i} = \exp (-U_i) \quad (6)$$

$0 \leq TE_1 \leq 1$

Where,

Y_i = Actual or observed output of the ith farmer
Y_i^* = Frontier output of the ith farmer

The inefficiency parameters of the farmers were estimated using the inefficiency model given as:

$$U_i = a_o + a_1z_1 + a_2z_2 + a_3z_3 + a_4z_4 + a_5z_5 + a_6z_6 + a_7z_7 + e_i \quad (7)$$

Where,

Z_1 = Age of farmers (years)
Z_2 = Sex of farmers (Male =1, female = 0)
Z_3 = Household size
Z_4 = Educational level (years)
Z_5 = Farmers experience (years)
Z_6 = Variety of rice cultivated (improved variety = 1, local variety = 0)
Z_7 = Number of improved technologies adopted
e_i = Error term

ISSN: 2319-9857

a's = unknown parameters to be estimated

The Maximum Likelihood Estimation (MLE) method of the stochastic frontier production function was estimated jointly with the inefficiency model using the computer program, FRONTIER Version 4.1 proposed by Coelli (1994).

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Rice Farmers and Production Inputs

The socio-economic characteristics of the rice farmers and their average production inputs are presented in Table 1. The results showed that rice production was dominated by the males (92%). The rice farmers were found to be relatively young, within the economically active age group (45 years old). Majority (79%) of the respondents were married with high average family size (10 persons). The high number of persons per family may indicate the availability of family labour to carry out the production activities. Majority (62%) of the respondents were literate. Level of education of the respondents may affect their access to useful information that may help to increase their productivity. The average year of farming experience of the respondents was high (17 years). The high level of experience may contribute to their ability to use resources more efficiently in their production. This agrees with the observation of Bamire et al [12]. Farming was the major occupation of the farmers as reported by majority (65%) of the respondents. As full-time farmers, it is expected that they would accord high attention to their production activities and hence may minimize waste in the use of resources. As regards access to credit, only few respondents (15%) had access to it. This means the farmers relied solely on personal savings to finance their production. The implication may be negative effect on production as personal savings may be inadequate to finance any substantial production. Agricultural credit is necessary to provide the required base for

Table 1: Socio-Economic Characteristics of Rice Farmers and production inputs

Variable	Average Statistics
Sex:	
Male (%)	92
Female (%)	8
Average age (Years)	45.34
Marital status:	
Single (%)	12
Married (%)	79
Divorce (%)	0.4
Widow/Widower (%)	9
Averag family Size	10
Educational Level:	
No Formal Education (%)	38
Primary Education (%)	18
Secondary Education (%)	18
OND/NCE (%)	15
HND/B.Sc and above (%)	11
Average Farming Experience (Years)	16.66
Occupation:	
Farming (%)	65
Civil Service (%)	20
Trading (%)	10
Others (Clergy, Mechanic, Carpentry) (%)	5
Access to Credit	
Yes (%)	15
No (%)	85
Use of Improved Variety	
Yes (%)	30
No (%)	70
Farm size (ha)	2.93
Family labour (mandays)	40
Hired labour (mandays)	36
Quantity of fertilizer (kg)	46.73
Quantity of rice seed (kg)	73.71
Quantity of herbicides (kg)	2.51
Yield/ha (kg)	2,424

Source: Field survey, 2009

increased production [1,26]. It was further found that the use of local rice variety was dominance among the respondents. This is evidenced by majority (70%) of the respondents that used it as against the few (30%) that used improved variety. This indicates low access of farmers to numerous improved rice varieties developed through research efforts. The implication may be low productivity. The average farm holding of the rice farmers in the study area was 2.93ha indicating that they were small-scale farmers. This is close to the average farm size of 2.59ha reported for small-scale traditional rice farmers in Nigeria [34]. With respect to labour operations, a total of about 76 mandays of manual labour was used per hectare in rice production. Of this, family labour used was dominance (53%) compared with hired labour (47%). This is at variance with the report of Okoruwa and Ogundele [34] in which an average labour input used per hectare in rice production was 85 mandays with family and hired labour having 75 and 10 mandays respectively. The average quantity of rice seed used in rice production per hectare (74kg) by the farmers was lower than the recommended average seed rate of 100kg/ha by IRRI (1995). This might lead to low plant population per unit area and consequently yield per unit area may be affected. Contrary to the recommended average fertilizer rate of 325kg/ha for rice [32], the respondents in the study area used less than a bag of fertilizer (47kg) per hectare. This is grossly inadequate, implying that, all things being equal, the productivity of rice might be low. As regards herbicides, the respondents applied an average of 2.51 litres/ha. This serves as labour saving for weeding operation which is very tedious in rice production. However, the quantity of herbicide used is low compared with the 6 litres/ha reported by Akpokodje *et al.* [7]. The study also found that the average yield of rice per hectare was 2,424kg, which is higher than the average rice yield of 2,130kg/ha reported for the North Central Agro-Ecological Zone of Nigeria [33]. It is however lower than the average potential yield of 3,760kg/ha reported for rice by NCRI [32], probably because of the low quantities of the various production inputs used.

Production Function for Rice: Estimated OLS and MLE Functions

The production function estimates using the OLS and MLE for rice in Nigeria as presented in Table 2 show that the log-likelihood ratio test (91.244) was significant at 1%. This indicates the significant presence of inefficiency parameters in the SFPF, meaning that the use of the classical regression model of production function based on OLS estimation technique would have been an inadequate representation of the data. Thus, the application of the SFPF using the maximum likelihood estimator was appropriate as it indicated a significant improvement over the OLS method. This is in consonance with a number of findings [3,19,34]. The coefficients of the MLE showed that farm size, family labour, hired labour, quantity of seed and quantity of herbicide significantly and positively influenced the yield of rice, while quantity of fertilizer had significant but negative effect on the output. The significance of farm size may be an indication of low use of yield enhancing technology and inputs in rice production. Farmers relied much more on farm land expansion to increase production [34]. Both family and hired labour were significant. This may be due to their high quantities used. Also, the significant use of herbicide may be an indication of the increased response of rice varieties to effective weed control. The negative effect of fertilizer is at variant with a priori expectation. This may not be unconnected with its low quantity used by the farmers. As earlier reported, the farmers used less than a bag of fertilizer per hectare (Table 1). It was also found that the model used was of good fit as evidenced by the value of the sigma squared (0.166) that was significant at 1%. The gamma coefficient (0.607) showed that technical inefficiency significantly accounted for about 61% of the variation in output of the rice farmers. This means that rice farmers in the study area require about 39% improvement on their output to operate on the production frontier.

Table 2: Estimates of the OLS and MLE Functions for Rice in Nigeria

Variable	Parameter	Average Function (OLS)	Frontier Function (MLE)
Constant	b_o	5.363	5.437
		(13.142)*	(11.928)*
Farm size (X_1)	b_1	0.422	0.663
		(2.329)*	(1.658)***
Family labour (X_2)	B_2	0.036	0.183
		(2.550)*	(1.714)***
Hired labour (X_3)	b_3	0.025	0.319
		(3.990)*	(2.296)**
Quantity of rice seed (X_4)	b_4	0.577	0.798
		(4.611)*	(5.956)*
Quantity of fertilizer (X_5)	b_5	-0.023	-0.021
		(-2.387)	(-2.431)**
Quantity of herbicide (X_6)	b_6	0.107	0.153
		(4.135)	(1.974)**
Sigma squared	δ^2_s	-	0.166
			(14.278)*
Gamma	γ	-	0.607
			(3.011)*
Log-Likelihood Function		-	-232.165
Log-Likelihood Ratio Test of one-sided error	LR	-	91.244*

* Significant at 1%; ** Significant at 5%; *** Significant at 10%

- Figures in parenthesis are t-ratios

Source: Field survey, 2009

Technical Efficiency of Rice Farmers

As presented in Table 3, the level of TE of the rice farmers ranged from 0.38 - 0.99 with 51% of the farmers falling within the range of 0.401 - 0.60. The average TE was about 0.61. This indicates that there was still ample opportunity (39%) for the farmers to increase their TE in rice production. This result agrees with the findings of Ehirim and Okorie [17] who reported an average technical inefficiency of 39.32% for maize farmers. Higher levels of average TE for farmers were, however, reported by Okoruwa and Ogundele [34], Erhabor and Emokaro [19], Ahmadu and Alufohai [3] and Onoja and Achike [36].

Table 3: Technical Efficiency of Rice Farmers in Nigeria

Technical efficiency range (%)	Frequency	Percentage (%)
0.201 - 0.400	2	1
0.401 - 0.600	150	51.30
0.601 - 0.800	121	41
>0.800	21	7
Total	263	100
Minimum TE	0.383	
Maximum TE	0.987	
Mean TE	0.605	

Source: Field survey, 2009

Determinants of Technical Inefficiency of Rice Farmers

The estimated inefficiency parameters of the rice farmers are presented in Table 4. The results showed that age of the farmers (coefficient = 0.008) was positively and significantly related to their technical inefficiency; while household size (-0.013), educational level (-0.011), farming experience (-0.004), rice variety (-0228) and number of improved technologies adopted (-0.048) were negative and significant determinants of the farmers' inefficiency. Sex was not significant. Positive relationship indicates that increase in the variable in question increases inefficiency while the reverse is the case for negative relationship. Inefficiency of the farmers increased with increase in age implying that older farmers were less efficient than the younger ones. This may be connected with the fact that young people are faster to adopt innovation [18] and hence may be more productive. This is in consonance with the findings of Onyenweaku and Nwaru [37] and Ahmadu and Alufohai [3]. Increased in the household size of the respondents decreased their inefficiency in production, indicating the vital role played by the family members in the production. This was expected because family labour accounted for the highest labour operations in rice production in this survey (Table 1); and findings revealed that large household size increased efficiency through labour contribution [2]. This suggests that increasing rice production may involve empowering the farm families. In this light, household poverty must be alleviated. The negative sign of educational level as determinant of inefficiency is in consonance with a priori expectation because education brings about enlightenment and enables one to access useful information that enhances efficiency in the use of resources [12]. The resultant effect is increased productivity and decreased inefficiency. Experience, it is often said, is the best teacher, and practice makes perfect. This may be reason why farming experience correlated negatively with the farmers' inefficiency. This corroborates the findings of Onyenweaku and Nwaru [37]and Ike [25] who established that level of education and farming experience have a positive relationship with efficiency in the use of resources. On rice variety, since the dummy 1 and 0 were used for improved and local rice varieties respectively, it means that inefficiency of the farmers decreased with increase in the use of improved variety and the reverse is the case for the use of local variety. This was expected because improved technology increases productivity more than local technology [8] all things being equal. In the same vein, as more number of improved technologies used by the farmers increased, their inefficiency decreased, which is also consistent with a priori expectation. It therefore means that if farmers should have access to adequate improved rice varieties and other production technologies, their productivity would be increased and rice production would be boosted.

Table 4: Inefficiency Parameters of Rice Farmers (2008 Production Season)

Variable	Parameter	Coefficient	t-ratio
Constant	a_0	0.656	0.740
Age of farmers (Z_1)	a_1	0.008	2.520*
Sex (Z_2)	a_2	-0.004	-0.058
Household size (Z_3)	a_3	-0.013	-2.236*
Educational level (Z_4)	a_4	-0.011	-3.013*
Farming experience (Z_5)	a_5	-0.004	-1.751***
Rice Variety (Z_6)	a_6	-0.228	-5.930*
Number of improved technologies adopted (Z_7)	a_7	-0.048	-3.645*

* Significant at 1%, *** Significant at 10%
Source: Field survey, 2009

CONCLUSION/RECOMMENDATIONS

The findings have shown that there was significant presence of technical inefficiency parameters in the SFPF. Technical inefficiency accounted for 61% of the variation in output of rice. The average TE of the farmers was 0.61, indicating that there was still ample opportunity (39%) for the farmers to increase their TE in rice production. Technical efficiency increased with increased in household size, educational level, farming experience, use of improved rice variety and number of improved technology adopted, but decreased with increased in age.

Based on the findings of the study and the implications, the following recommendations are therefore made:

- Since the farmers used low quantities of inputs such as fertilizer and herbicide,
- Government should subsidize the costs of these inputs and make them available in sufficient quantities to the rice farmers through designated government organizations and ministries such as ADP, Ministry of Agriculture and Research Institutes only.
- Sales of the subsidized inputs in the public markets should be prohibited and this
- Should be enforced. This is to prevent the hijacking of the inputs by wealthy individuals who will in turn sell them to the farmers at exorbitant cost, thus, constraining the farmers from buying sufficient quantities.
- Since there was low access to credit facility by the farmers, government and financial
- Institutions should make agricultural credit more accessible to farmers. Stringent measures and bureaucratic procedures for accessing agricultural credit should be minimized.
- Rice farmers on their part should form co-operative societies and/or join Rice Farmers
- Association of Nigeria to ease their accessibility to farm inputs, especially agricultural credit.
- Low access of farmers to improve rice varieties developed through research efforts
- Could be minimized by strengthening and refocusing the extension services in the country.
- Since young farmers were more technically efficient than older ones, government
- Should create enabling environment to make farming attractive to the youth. This will settle them down to concentrate on farming.
- Similarly, since level of education correlates positively with TE, effort should be
- Intensified in the provision of adult education to aged and uneducated farmers. This could be achieved by the establishment of adult literacy schools in all the rural areas and revitalizing any existing ones.

REFERENCES

1. Adegeye AJ, Dittoh JS. 1985, Essentials of Agricultural Economics, Impact Publisher Nig. Ltd., Ibadan, pp. 116 – 118.
2. Adewuyi SA, Okunmadewa FY. Economic Efficiency of Crop Farmers in Kwara State, Nigeria, Nigeria Agricultural Development Studies. 2001: 2 (1) : 45 – 57.
3. Ahmadu J, Alufohai GO. A Comparative Analysis of Technical Efficiency of Mechanized and Non-Mechanized Cassava Farmers in Egor and Oredo Local Government Areas of Edo State. Nigeria J Agric Forestry Soc Sci. 2008; 6(1): 90 – 101.
4. Aigner DJ, Lovell CAK, Schmidt P. Formulation and Estimation of Stochastic Frontier Production Function Models, J Economet. 1977;6:21 – 37.
5. Ajibefun AI, Battese GE, Daramola AG. Determinants of TE in Smallholder Food Crop Farming in Oyo State: Application of Stochastic Frontier Production Function. Quart J Int Agric. 2002;41(3):225 – 240.
6. Ajibefun AI, Battese GE, Kada R. Technical Effciency, Technological Change and Productivity of Hired and Family Labour in Japanese Rice Industry. Emp Econ Lett. 2002; 1 (1): 21 – 31.
7. Akpokodje G, Lancon F, Erenstein O. 2001, The Nigerian Rice Economy in a Competitive World: Constraints, Opportunities and Strategic Choices, Nigeria's Rice Economy: State of the Art, West Africa Rice Development Association (WARDA), Bouake, Cote d'Ivoire. Htt://pdf.dec.org/pdf-docs/pnadb851.pdf
8. Alabi RA. 2004, Economic Efficiency of Cocoa-Based Agroforestry System in Oyo State, Nigeria, A Ph.D Thesis, Department of Agricultural Economics and Extension, Federal University of Technology, Akure, Ondo State, Nigeria.
9. Ali AI, Seiford LM. 1993, The Mathematical Programming Approach to Efficiency Analysis, In: Fried, H.O.; Lovell, C.A.K. and Schmidt, S.S. (eds), The Measurement of Productive Efficiency, Oxford University Press, New York, pp. 120 – 159.
10. Amaza PS, Onu JI, Okunmadewa FY. Identification of Factors that influence TE of Cotton Farmers in Nigeria. Nigeria Agric Develop Studies. 2001;2(1):133 – 146.
11. Atungwu JJ, Afolam SO, Sosanya OS, Odeyemi IS, Adesuvi RA. 2005, Evaluation of Two Varieties of Lowland Rice for Resistance to Root-Knot Nematodes, Proceedings of the 39th Annual Conference of the ASN held at the University of Benin, Benin City, Nigeria. 9th – 13th October, pp. 95 – 97.
12. Bamire BS, Oluwasola O, Adesiyan AJ. 2007, Land Use and Socio-Economic Determinants of TE of Rice Farms in Osun State, Nigeria, In: Haruna, U.; Jibril, A.; Mancha, Y. P. and Nasiru, M. (eds) proceedings of the Nigerian Association of Agricultural Economics (NAAE), pp. 27 -35.
13. Battese GE, Coelli TJ. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. Emp Econ. 1995 20: 325 – 332.

14. Bravo-Ureta BE, Rieger L. Dairy Farm Efficiency Measurement Using Stochastic Frontier and Neoclassical Duality. American J Agric Econ. 1991;73:421 – 428.
15. Centre for Efficiency and Productivity (CEPA) (2000): Short Course on Production Economics, Productivity and Efficiency Measurement, CEPA, New England , pp. 1 -170.
16. Daramola B. 2005, Government Policies and Competitiveness of Nigerian Rice Economy, A Paper Presented at the Workshop on Rice Policy and Food Security in Sub-Saharan Africa Organized by WARDA, Cotonou, Republic of Benin, 7th – 9th November. www.warda.org/workshop/ricepolicy/Biyi/Biyi.D.Nigeria.paper.pdf
17. Ehirim NC, Korie OC. Farm Input Interactions and Technical Efficiency Among Small-Holder Maize Farmers in Imo State, Nigeria. J Agric Res Policies. 2008;3(1): 46 – 52.
18. Ekpere JA. 1990, Agricultural Extension: Search Light of the Nigerian Small-Scale Farmers, University Lecture, University of Ibadan, Nigeria.
19. Erhabor PO, Emokaro CO. Relative Technical Efficiency of Cassava Farmers in the Three Agro-Ecological Zones of Edo State, Nigeria. J App Sci. 2007; 7(19):2818 – 2823.
20. Farel R, Grosskopt S, Lovell CAK. 1994, Production Frontiers, Cambridge University Press.
21. Farrell JM. The Measurement of Production Efficiency. J Royal Stat Soc Series. 1957;120:257 – 290.
22. Food and Agriculture Organization Statistics (FAOSTAT) (2008a): Trends in the Rice Economy: Paddy Rice Production Area, FAO Statistics Division. http://beta.irri.org/statistics/images/stories/wrs/wrs-novo8-tables-
23. Food and Agriculture Organization Statistics (FAOSTAT) (2008b): Calorie Supply Intake, FAO Statistics Division. http://beta.irri.org/statistics/index.php?option=com-content&task+view&id= 62&itemid
24. Hossain M, Narciso J. 2004, Global Rice Economy: Long-Term Perspectives, A Paper Presented at the FAO Rice Conference on “Rice in Global Markets and Sustainable Production Systems” held in Rome, Italy on 12th – 13th February to Celebrate the International Year of Rice.
25. Ike PC. Estimating Production TE of Irvingia Seed (Ogbono) Species Farmers in Nsukka Agricultural Zone in Enugu State, Nigeria. J Sust Trop Agric Res. 2008; 28:1 – 7.
26. Ilavbarhe KO, Ahmadu J. 2007, Profitability of Poultry Feed Marketing in some selected Markets in Benin Metropolis, Edo State, Nigeria, Journal of Agriculture, Forestry and Fisheries, University of Benin, Benin City, Nigeria (accepted).
27. Ilevbaoje IE, Ingawa SA. 2008, Nerica Rice Flourishes in Nigeria: The Magic Wand of Multinational Nerica Rice Dissemination Project, Proceedings of the 10th Annual National Conference of Nigerian Association of Agricultural Economists (NAAE) held at University of Abuja, 7th – 10th October, pp. 267 – 275.
28. International Rice Research Institute (2004): World Rice Statistics.
29. Jondrow J, Lovell CAK, Materov IS, Schmidt P. An Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. J Economet. 1982; 19 : 233 – 238.
30. Lewin AY, Lovell CAK. Editors Introduction, J Economet. 1990; 46 : 3 – 5.
31. Meeusen W, Van den Broeck J. Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error, Int Econ Rev. 1977:18:435 – 444.
32. National Cereals Research Institute (NCRI) (2008): Training Manual on Rice Production and Processing, NCRI, Badeggi, pp.15 – 27, 73 – 77.
33. National Food Reserve Agency (NFRA) (2008): Report of the 2007 Agricultural Production Survey, Federal Ministry of Agriculture and Water Resources pp. 1 – 88.
34. Okoruwa VO, Ogundele OO. 2004, Technical Efficiency Differentials in Rice Production Technologies in Nigeria. www.csae.ox.ac.uk/conference/2006-E01-RPI/papers/csae/okoruwa.pdf
35. Olayide SO, Heady EO. 1982, Introduction to Agricultural Production Economics, Ibadan University Press, Ibadan, Nigeria, p. 33.
36. Onoja AO, Achike AI. 2008, Technical Efficiency of Rice Production Under Small-Scale Farmer-Managed Irrigation Schemes and Rainfed Systems in Kogi State, Nigeria, Proceedings of 10th Annual National Conference of NAAE held at University of Abuja, Abuja, FCT, 7th – 10th October, pp. 242 – 252.
37. Onyenweaku CE, Nwaru JC. Application of a Stochastic Frontier Production Function to the Measurement of TE in Food Crop Production in Imo State, Nigeria. The Nigerian Agric J. 2005;36 : 1 – 12.
38. Seiford IM, Thrall RM. Recent Development in DEA: The Mathematical Approach to Frontier Analysis. J Econ. 1990:46:7 – 38.
39. Tiamiyu SA, Akintola JO, Rahji MAY. 2008, Potential for Rainfed Upland Rice Productivity Growth in Guinea Savannah Zone of Nigeria, Proceedings of 10th Annual National Conference of NAAE held at University of Abuja, Abuja, FCT, 7th – 10th October, pp. 70 – 77.
40. Zaibet L, Dharmapala PS. Efficiency of Government-Supported Horticulture: The Case of Oman. Agric Systems. 1999;62: 159 – 168.