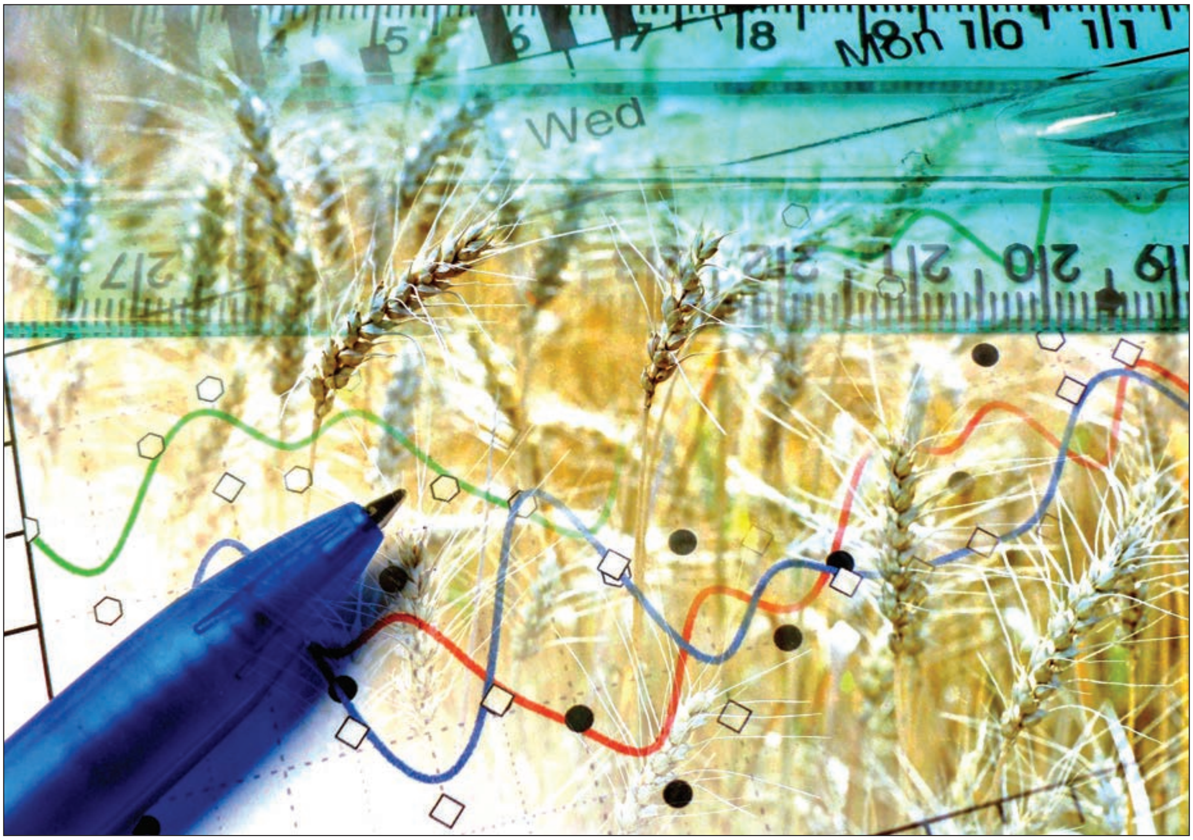

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A Comparative Analysis of Economic Efficiency Between Traditional and Improved Rice Varieties Farmers in Oriade Local Government Area of Osun State

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ABSTRACT

There is a well established and growing demand for rice in Nigeria as a major staple. Only about half of that demand is met by domestic production, the availability and prices of rice directly impact on the welfare of the poorest Nigerian consumers due to the fact that consumption runs ahead of local production. The study examines and compares the technical, allocative and economic efficiency between improved and traditional rice farmers in Oriade local government area of Osun state. Primary data were collected from 60 traditional and 60 improved rice farmers. Data obtained was analyzed using Cobb-Douglas production and cost function. The result revealed that farm size and agrochemical were significant factors which influence both rice technologies in the area. The return to scale (RTS) reveals that both improved and traditional rice production were in stage II of production surface. The result of the cost frontier shows that labour, agrochemical and output were significant for both for both rice technologies while fertilizer and seed were significant for improved and traditional rice production, respectively. The mean technical efficiency for improved rice production is 0.84 and 0.329 for traditional rice production while allocative and economic efficiencies mean values for both improved and traditional rice are 0.931, 0.773, 0.861 and 0.278, respectively. Conclusively, there is existence of inefficiency in cost for both the traditional and improved rice technologies.

Key words: Rice varieties, economic efficiency, stochastic frontier, technical efficiency

INTRODUCTION

Rice (*Oryza sativa*) according to Jamala *et al*. (2011) is one of the cereals most commonly consumed in the world, especially in Asia and Africa and specifically in Nigeria. According to Kumar *et al*. (2008), rice is the prime source of food for nearly half of the World`s population and it is one of the most important major food crops. It was noted that since 1973, West Africa's demand for rice has grown at an annual rate of 6% driven by the population growth of 2.9%. Rice farming is widespread in Nigeria. Recent field survey indicates that overall crop yield improved in 2001 due largely to increased growers usage of improved varieties. All the ecologies in Nigeria are suitable for cultivation of rice hence; the nation has the capacity to be self sufficient in rice production. However, all ecologies in the country are plagued by low and decreasing yields, partly as a result of increasing production costs and lack of available inputs mainly fertilizer. Arising from this, rice that is milled traditionally has low demand due to its poor quality. The demand for rice is expected to grow substantially in sub-Sahara Africa as the population is increasing at the rate of 3.4% per annum and demand for rice is growing faster than other major staple foods (Akinwale *et al.*, 2011).

Despite Nigeria's potentials, particularly in terms of land availability, human and capital resources needed to produce enough food for its inhabitants, there is still food deficit, because Nigeria depends on the food importation for the welfare of its people. Consequent upon this, the agricultural sector has ceased from being a major contributor to the foreign earnings of the country. The bulk of rice consumed in Nigeria is imported mostly from Asia, Due to the effect of climate change, most of the world highest producers of rice like Thailand have decided to put on hold export of the commodity in order to satisfy traditional needs. Despite several efforts of domestic production of rice, Africa has not been able to meet traditional market demands, forcing many of the countries in the continent to rely on import. According to Ajetomobi *et al.* (2011), the production of rice in Nigeria is generally affected not only by availability of land, labor, capital and management of this product but also by the efficiency of production. If the farmers are efficient in the allocation of inputs, this will lead to minimization of cost. As a result, they maximize profit and are encouraged to produce more thus leading to food security in rice production.

The term efficiency is often used synonymously with productivity, the most common measures of which relate output to single input (Lund and Hill, 1979). According to Lovell (1993), the term efficiency refers to the comparison between the real or observed values of input(s) and output(s) with the optimal values of input(s) and output(s) used in a particular production process. Efficiency is achieved either by minimizing the resources required for producing a given output. Moreover, according to the optimal values, two types of efficiency can be distinguished, that is technical efficiency and allocative efficiency. According to Njeru (2004), the ability of a firm to maximize output given a set resource input is known as Technical efficiency while allocative efficiency is the ability of a firm to use inputs optimally given their prices and production technology. On the other hand, economic efficiency can be described as capacity of the firm to produce a predetermined quantity of output with minimum cost at a given level of technology (Farrell, 1957; Kopp and Diewert, 1982). This study therefore seeks to compare the economic efficiency between tradition and improved rice varieties farmers in Oriade Local Government Area of Osun state:

- Ho1: Rice farmers are economically inefficient
- Ho2: Efficiency indexes of rice farmers is not affected by their socio-economic characteristics

MATERIALS AND METHODS

The area of the study is Oriade local government of area of Osun state. The headquarters of this local government is situated at Erin-Oke town. The local government area has average population size of about 148,617 people (NPC, 2006). The area is located in the south western part of the country; it is situated on latitude 7°.45E and longitude 4°.45N. Simple random sampling technique was used to select 120 respondents from the list of registered rice farmers in the local government area. The data obtained were analyzed using both descriptive and inferential statistics.

Conceptual framework: Over the last decades, Farrell methodology has been applied widely, while undergoing many refinements and improvements. The model that will be used in this paper will be based on an extension advanced by Kopp and Diewert (1982) and further modified by

Bravo-Ureta and Rieger (1990). To begin with, assume that a deterministic production frontier function is given by the equation:

$$Y_j = g\ (X_{ij};\ \beta) \tag{1}$$

where, Yj is the output of the jth farm, X_{ij} is the ith input used by farm j and B is a vector of unknown parameters. To simplify the exposition, the subscript j is dropped in what follows. From Eq. 1, it is possible to derive the technically efficient input quantities (X_{it}) for any given level of output Y, by solving simultaneously the following equations:

$$\begin{aligned} &Y = g\ (X_i;\ \beta) \\ &X_1/X_i = k_i \qquad k_i\, X_i\ (i>1) \end{aligned} \tag{2}$$

where, k_i is the ratio of the observed level of inputs X_1 and X_i (i>1) at output Y.

Next, assume that the production frontier Eq. 1 is self- dual (e.g. Cobb-Douglas) and that the corresponding cost frontier can be expressed as:

$$C = h\ (P,\ Y;\ \alpha) \tag{3}$$

where, C is the minimum cost of producing output Y, P is a vector of input prices and is a vector of parameters. Applying Shephard's lemma, the system of minimum cost input demand equations can be obtained by differentiating the cost frontier with respect to each input prices. This demand equation for the ith input X_{di} is equal to:

$$\partial C/\partial\ P_i = X_{di} = f\ (P,\ Y;\ \Phi) \tag{4}$$

where, Φ is a vector of parameters. From the input demand equations, the economically efficient input quantities, X_{ie} can be obtained by substituting the firm's input prices P and output Y in to Eq. 4.

Thus far, the input bundles X_i, X_{it} and X_{ie} have solved. It is now possible to calculate the cost of actual or observed (COB) input bundle as $\sigma x_i P_{i,}$ while the cost of the technically (CTE) and economically efficient (CEE) input combinations associated with the firm's observed output is given by $\Sigma X_{it}\ P_i$ and $\Sigma X_{ie}\ P_i$, respectively.

These cost measures are the basis for calculating TE and EE as follows:

$$TE = \Sigma X_{it}P_i/\Sigma X_iP_i = CTE/COB \tag{5}$$

$$EE = \Sigma X_{ie}P_i/\Sigma X_iP_i = CEE/COB \tag{6}$$

As already mentioned in the Farrell (1957) methodology, EE is equal to the product of TE and AE; hence Eq. 5 and 6 are used to calculate AE as:

$$AE = EE/TE = \Sigma X_{ie}P_i/\Sigma X_{it}P_i = CEE/CTE \tag{7}$$

The Kopp and Diewert (1982) approach is based on a deterministic frontier function, which imposes a limiting assumption that the entire deviation from the frontier is due to inefficiency.

Schmidt (1986), among others, argued that efficiency measures obtained from deterministic models are affected by statistical noise. For this reason, Bravo-Ureta and Rieger (1991) used a stochastic production frontier function in order to remove the random element from the efficiency component before deriving the various efficiency indices.

The stochastic production frontier function can be written as:

$$Y = f\,(X_i;\ \boldsymbol{\beta}) + \varepsilon \tag{8}$$

where, Y, X_i and $\boldsymbol{\beta}$ are as defined earlier. The essential idea behind the stochastic frontier model is that ε is a "composed" error term (Aigner *et al*., 1977; Meeusen and van den Broeck, 1977). This term can be written as:

$$\varepsilon = V - U \tag{9}$$

where, V is a two-sided ($-\infty<V<\infty$) normally distributed random error ($V\sim N\,(0,\ \sigma^2_v)$ that captures the stochastic effects outside the farmer's control (e.g., weather, natural disaster and luck), measurement errors and other statistical noise. The term U is a one-sided (u>O) efficiency component that captures the technical inefficiency of the farmer. In other words, U measures the shortfall in output Y from its maximum value given by the stochastic frontier function f (X_i; $\boldsymbol{\beta}$)+V. This one-sided term can follow such distributions as half normal, exponential and gamma (Aigner *et al*., 1977; Greene, 1980; Meeusen and van den Broeck, 1977). In this study, it was assumed that u follows a half-normal distribution ($U\sim N\,(0,\ \sigma_u^2)$ as typically done in the applied stochastic frontier literature. The two components V and U are also assumed to be independent of each other thus COV (V, U) = O.

The maximum likelihood estimation of Eq. 8 yields consistent estimators of $\boldsymbol{\beta}$, λ and σ^2 where $\boldsymbol{\beta}$ is a vector of unknown parameters, $\lambda = \sigma_u/\sigma_v$ and $\sigma^2 = \sigma_u^2+\sigma_v^2$. Jondrow *et al*. (1982) have shown that inferences about the technical inefficiency of individual farmers can be made by considering the conditional distribution of U given the fitted values of and the respective parameters. In other words, given the distribution assumed for V and U and assuming that these two components are independent of each other, the conditional mean of u given ε is defined by:

$$E(\mu/\varepsilon) = \delta * \frac{\left[f^*(\varepsilon_j\ \lambda/\delta) - \varepsilon_j\ \lambda\right]}{1-F^*\,(\varepsilon j\ \lambda/\delta)\ \delta} \tag{10}$$

where, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$, f* is the standard normal density function and F* is the distribution function, both functions being evaluated at $\varepsilon_j\,\lambda/\delta$.

Consequently, by replacing ε, σ_* and λ by their estimates in Eq. 8 and 10, we derive the estimates of V and U. Subtracting V from both sides of Eq. 8 yields the stochastic frontier function:

$$Y^* = f\,(X_i;\ \beta) - u = Y - V \tag{11}$$

where, Y* is defined as the farm's observed output adjusted for the statistical noise contained in V (Bravo-Ureta and Rieger, 1991). Equation. 11 is used to compute X_{it} as well as to derive the cost frontier function. The cost frontier function is then used to obtain the minimum cost factor demand equations, which in turn, become the basis for calculating the economically efficient input.

Production frontier function: For the purpose of this study, the specific models estimated as adopted by Coelli (1996) are:

A Cobb-Douglas production frontier function:

$$\text{In } Y = \text{In}\alpha + \sum_{i=1}^{6} \beta_i \ \text{In } X_i + V_i - U_i \tag{12}$$

Where:
Y = Rice output (kg)
X_1 = Farm size (ha)
X_2 = Family labour used in rice production (Man days)
X_3 = Hired labour used in rice production (Man days)
X_4 = Quantity of fertilizer used (kg)
X_5 = Quantity of agrochemicals used (liters)
X_6 = Value of seeds used (kg)
α and $\boldsymbol{\beta}_i$ = Parameters to be estimated
i = 1, 2, ..6
V_i = A two sided normally distributed random error
U_i = A one sided efficiency component with a half normal distribution

Where:

$$U_i = \boldsymbol{\delta}_0 + \sum_{i=1}^{4} \delta_i Z_i \tag{13}$$

Where:
Z_1 = Age of the rice farmers (years)
Z_2 = Years of education of the rice farmers
Z_3 = Years of farming experience in rice production
Z_4 = Household size of the rice farmers in an house (No. of people)
i = 1, 2, ..4

A Cobb-Douglas functional form was used to specify the stochastic production frontier, which is the basis for deriving the cost frontier and the related efficiency measures. The use of single equation model in Eq. 12 and 14 below is justified by assuming that Nigerian farmers maximize expected profits (Bravo-Ureta and Rieger, 1990; Caves and Barton, 2004; Kopp and Smith, 1980), despite its well known limitation, the Cobb-Douglas production function is chosen because the methodology employed requires that the production function be self dual. It is also worth stating that this functional form has been widely used in farm efficiency analysis for both developing and developed countries.

A transformed Cobb-Douglas cost frontier function:

$$\text{InC} = \beta_o \sum_{i=1}^{5} \beta_i \ \text{In } P_i + \boldsymbol{\beta}_6 \ \text{InY} + V_i + U_i \tag{14}$$

Where:
C = The cost of rice production per farm (N)

P_1 = The average rent per hectare of land (N)
P_2 = The cost of labour used (N)
P_3 = The average price of fertilizer used (N)
P_4 = The average price of agrochemicals used (N)
P_5 = The quantity of seed used (N)
Y = The total farm output measured in kilograms and adjusted for any statistical noise as previously specified in Eq. 11

Statistical analysis: Data collected were statistically analyzed using FRONTIER 4.1 data processing package (Software) to estimate the efficiency level of the rice farmers using 1, 5 and 10% level of significance.

RESULTS AND DISCUSSION

Estimated of the stochastic frontier production functions

Estimated production functions: The Maximum Likelihood (ML) estimates of the production parameters for rice farmers in Oriade Traditional Government area of Osun state is presented in Table 1. The coefficient of farm size was found to be positive and significant at the 1% level in both the improved and traditional rice farmers. This implies that farm size is a significant factor that influences both rice technology output in the study area. This finding agrees with the study of Ogundele and Okoruwa (2006), Shehu and Mshelia (2007) and Idiong (2007). Family labor has a significant but negative relationship with rice output in both improved and traditional rice farmers. The coefficient of fertilizer has a positive and significant relationship (at 10% level of significance) with rice output in Traditional rice farmers while it has a negative and insignificant relationship with improved rice farmers. This underscores the low use of fertilizers by the improved rice farmers. The coefficient of agrochemical was found to be significant at 10 and 5% significant level in both the improved and traditional rice farmers, respectively. This implies that agrochemical is a positive factor that influences improved rice output while it is a negative factor in Traditional rice output. The coefficient of seed has a significant and positive influence with only improved rice output in the study area. This finding is not in consonant with the earlier findings by Shehu and

Table 1: Maximum likelihood estimates of the stochastic frontier production function

	Rice varieties farmer	
Variable	Improved	Traditional
Constant	2.410 (6.192)	1.840 (2.208)
Farm size (X_1)	0.459 (8.054)***	0.460 (3.699)***
Family labour (X_2)	-0.223 (-4.109)***	-0.246 (-1.724)***
Hired labour (X_3)	-0.0445 (-0.623)	-0.0108 (-0.075)
Fertilizer (X_4)	-0.0266 (-0.232)	0.280 (1.651)*
Agrochemical (X_5)	0.189 (1.702)*	-0.301 (-2.168)**
Seed (X_6)	0.146 (2.732)***	0.0848 (0.687)
Sigma square	0.356 (1.967) **	0.247 (2.628)***
Gamma	0.843 (9.374)***	0.724 (4.371)***
Log likelihood function	-207.905	-201.516
RTS	0.4999	0.267

*,**, ***Estimates significant at 10, 5 and 1% level of significance, RTS: Return to scale

Mshelia (2007) who reported a negative and significant relationship between output and seed. However, it is in line with the findings of Idiong (2007) and Piya *et al.* (2012).

The estimate of sigma squares (0.356 in improved and 0.247 in Traditional rice farmers are significantly different from zero at different levels. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. This suggests the conventional production function is not an adequate representation of the data. Moreover, the estimate of gamma, which is the ratio of the variance of farm-specific technical efficiency to the total variance of output, was 0.843 in improved rice farmers and 0.724 in Traditional rice farmers. This indicates that about 84.3 and 72.4% of the variation in output among farms is due to the differences in their technical efficiencies among improved and traditional rice farmers, respectively. This result is consistent with the findings of Shehu and Mshelia (2007).

The return to scale (RTS) analysis which serves as a measure of total resource productivity is also given in Table 1. The RTS parameter (0.4999 in improved and 0.267 in Traditional rice farmers) is obtained from the summation of the coefficients of the estimated inputs elasticities which indicates that both the improved and Traditional rice production in the study area was in stage II of the production surface. Stage II is the stage of decreasing positive return to scale where resources and production was believes to be efficient. Hence, it is advisable that the production units should maintain the level of input utilization at this stage as this will ensure maximum output from a given level of input *Ceteris paribus*. This result is not consistent with the findings of Shehu and Mshelia (2007) and Idiong (2007) who reported more than one RTS.

Estimates of the stochastic cost frontier: The estimates of the stochastic frontier cost function are presented in Table 2. The result revealed that all the independent variables conform to *a priori* expectation as all the estimated coefficients gave positive coefficients except rent in improved rice variety, meaning as these factors increased, total production cost increased *Ceteris paribus*. The result of t-ratio test shows that in improved rice variety, the significant variables are labour, fertilizer, agrochemical and output while the significant variables in the Traditional rice variables are labour, agrochemical, seed and output.

The economic efficiency analysis of both rice farmers revealed that there was presence of cost inefficiency effects in rice production as confirmed by the significance gamma value of 0.916 and 0.967 in improved and traditional rice farmers, respectively. This implies that

Table 2: Maximum likelihood estimates of stochastic frontier cost function

	Rice varieties farmer	
Variable	Improved	Traditional
Constant	55127.113 (1.179)	-29787.0 (-0.874)
Rent	-82.217 (1.429)	25.659 (0.647)
Labour	1.046 (11.963)***	1.098 (25.461)***
Fertilizer	1.032 (3.558)***	0.289(1.603)
Agrochemical	2.126 (2.921)***	1.253 (4.611)***
Seed	0.644 (0.569)	3.411 (4.418)***
Output	285.968 (1.782)*	254.886 (2.493)**
Sigma square	463.891 (4.650)***	357.876 (3.534)***
Gamma	0.91600	0.96700
Log likelihood function	-626.765	-768.223

*,**, ***Estimates are significant at 10, 5 and 1% level of significance

about 92 and 97% variation in the total production cost is due to differences in their cost efficiencies among improved and Traditional rice farmers, respectively.

Efficiency indexes for rice farmers in the study area

Technical efficiencies (TE) indexes: The result derived from ML estimates indicate technical efficiency (TE) indices range from 0.0279 to 1 with a mean value of 0.842 for farmers planting improved variety (Table 3). This means that for an average efficient farmer to achieve the technical efficiency level of its most efficient counterpart he could realize about (1-0.842/1) savings in cost or increase in production. This gives about 15.8% increase in production or cost saving. The least efficient farmers can now save a cost or increase in production of 97.9%. (1-0.279/1) to achieve the required technical efficiency of the most efficient farmers in the study area. Also, the technical efficiency indices range from 0.0237 to 1 with a mean of 0.329 for farmers planting Traditional varieties. This means that for an average efficient farmers to achieve the technical efficiency level of its most efficient counterpart, he could realize about 67.1% increase in production or cost saving. Also, the least efficient farmers can now save a cost or increase in production of 99.8 % to achieve the required technical efficiency of the most efficient farmers.

To give a better indication of the distribution of TE, a frequency distribution of the predicted TE is presented in Table 3. The frequencies of occurrence of the predicted TE in decile range indicate that the highest number of farmers have TE between 0.91 to 1.00 in improved rice farmers, representing about 30% of the respondents. While the highest numbers of farmers have TE between 0.11 and 0.20 in Traditional rice farmers representing about 22% of the respondents. Also, 38.3 and 8.4% of the improved and traditional rice farmers, respectively have TE of above 0.70 which is an indication that both improved and traditional rice farmers are inefficient.

Allocative efficiency (AE) indices: The result derived from ML estimates indicates that allocative efficiency (AL) indices ranged from 0.0622 to 1 with a mean of 0.931 for farmers planting improved variety (Table 4). This implies that for an average efficient farmer to achieve allocative efficiency level its most efficient counterpart, he could realize about (1-0.931/1) saving in cost or increase in production. This gives about 6.9% increase in production or cost saving. The least

Table 3: Decile range of frequency distribution of technical efficiency of the farmers

	Improved varieties farmer		Traditional varieties farmer	
Efficiency	Frequency	Percentage	Frequency	Percentage
0.01-0.10	11.0	18.3	8	13.3
0.11-0.20	5.0	8.3	13	21.7
0.21-0.30	2.0	3.3	12	20.0
0.31-0.40	12.0	20.0	8	13.3
0.41-0.50	5.0	8.3	9	15.0
0.51-0.60	0.0	0.0	3	5.0
0.61-0.70	2.0	3.3	2	3.3
0.71-0.80	5.0	8.3	1	1.7
0.81-0.90	0.0	0.0	1	1.7
0.91-1.00	18.0	30.0	3	5.0
Mean	0.842		0.329	
Minimum	0.0279		0.0237	
Maximum	1.0		1.0	

Table 4: Decile range of frequency distribution of allocative efficiency of the farmers

	Improved varieties farmer		Traditional varieties farmer	
Efficiency	Frequency	Percentage	Frequency	Percentage
-0.10	-	-	-	-
0.11-0.20	-	-	-	-
0.21-0.30	-	-	-	-
0.31-0.40	-	-	-	-
0.41-0.50	-	-	3.000	5.0
0.51-0.60	-	-	3.000	5.0
0.61-0.70	1.000	1.70	1.000	1.7
0.71-0.90	-	-	4.000	6.7
0.81-0.90	11.000	18.30	24.000	40.0
0.91-1.00	48.000	80.00	25.000	41.7
Mean	0.931		0.861	
Minimum	0.622		0.445	
Maximum	1.000		1.000	

efficient farmer can now save a cost or increase in production of 37.8% (1-0.622/1) to achieve the required allocative efficiencies of the most efficient farmers in the study area. Also, the allocative indices range from 0.445 to 1, with a mean of 0.861 for farmers planting Traditional varieties. This means that for an average efficient farmer to achieve allocative efficiency level of its most efficient counterpart, he could realize about (1-0.861/1) percent increase in production or cost savings. This gives about 13.9% increase in production or cost savings. Also, the least efficient farmer can now save a cost or increase in production of 55.5% to achieve the required allocative efficiency of the most efficient farmers.

To give a better indication of the distribution of the AE, a frequency distribution of the predicted AE is presented in Table 4. The frequency of the occurrence of the predicted AE in decile range indicates that the highest numbers of farmers have AE between 0.93-1.00 in Traditional rice farmers representing about 42% of the respondents while the highest numbers of farmers in improved rice variety have AE of 0.91 to 1.00, representing about 80% of the respondents. Also, 98.3 and 88.4%s of improved and traditional rice farmers, respectively have AE of above 0.70 which is an indication that both improved and traditional farmers are inefficient.

Economic efficiency (EE) indices: The result derived from ML estimate indicates that economic efficiency (EE) indices range from 0.0283 to 1, with a mean of 0.773 for farmers planting improved varieties (Table 5). This means that for an average efficient farmer to achieve economic efficiency level of its most efficient counterparts, he could realize about (1-0.773/1) saving in cost or increase in production. This gives about 22.7% increase in production or cost savings. The least efficient farmers can now save a cost or increase in production of 97.1%. (1-0.0283/1) to achieve economic efficiency of the most efficient farmer in the study area. The EE indices range from 0.0231 to 0.834 with a mean of 0.278 for farmer planting Traditional varieties. This means that for an average efficient farmer to achieve the EE level of its most efficient counterpart, he could realise about (72.2)% increase in production or cost saving. Also the least efficient farmer can now save a cost or increase in production of 16.5% to achieve the required economic efficiency of the most efficient farmers.

Table 5: Decile range of frequency distribution of economic efficiency of the farmers

	Improved varieties farmer		Traditional varieties farmer	
Efficiency	Frequency	Percentage	Frequency	Percentage
-0.10	13	21.7	11	18.3
0.11-0.20	3	5.0	19	31.7
0.21-0.30	3	16.5	11	18.3
0.31-0.40	10	16.7	9	15.0
0.41-0.50	6	10.0	3	5.0
0.51-0.60	1	1.7	2	3.3
0.61-0.70	2	3.3	1	1.7
0.71-0.90	3	5.0	1	1.7
0.81-0.90	1	1.7	3	5.0
0.91-1.00	18	30.0	-	-
Mean	0.773		0.278	
Minimum	0.0283		0.0231	
Maximum	1		0.0834	

Table 6: Regression result of relationship between efficiency indices and some socio-economic variables

	Efficiency indices (improved)		
Variables	TE	AE	EE
Constant	-0.0872 (-0.283)	-0.245 (-0.429)	-2.840 (1.517)
Age	0.0872 (0.613)	1.573 (1.339)	4.068 (1.054)
Education	5.820 (1.749)*	3.473 (1.265)	0.139 (1.546)
Experience	2.034 (0.126)	2.669 (1.388)	9.297(2.472)**
Household size	-1.68 (-0.425)	-2.67 (-0.815)	-8.46 (-0.787)
R^2	0.109	0.303	0.248
F	1.396	4.951*	3.750*

*,**,***Estimates are significant at 10 and 5% level of significance

To give a better indication of distribution of the EE, a frequency distribution of the predicted EE is presented in Table 5. The frequencies of occurrence of the predicted EE in deciles range indicate that the highest number of farmers have EE between 0.91-1.00 in improved rice farmers, representing about 30% of the respondents while the highest number of farmers have EE between 0.11-0.20 in Traditional rice farmers representing about 32% of the respondents. Also, 36.7 and 6.7% of improved and traditional rice farmers, respectively have EE of above 0.70 which is an indication that both improved and traditional rice farmers are inefficient.

Relationship between efficiency indexes and socio economic variables under improved rice variety: To investigate the relationship between efficiency indexes and socio-economic variables, regression analysis was carried out.

The results presented in Table 6 revealed a non significant relationship between age and all efficiency indexes among the improved rice farmers. Education was found to have a positive relationship with all the efficiency indexes (TE, AE and EE) but insignificant with AE and EE in improved rice farmers. This implies that improved rice farmers with greater years of formal education tend to be more technically efficient. This agrees with the findings of Amaza and Tashikalma (2003); Amos *et al.* (2004) and Shehu and Mshelia (2007).

Table 7: Regression result of relationship between efficiency indexes and some socio-economic variables

	Efficiency indices (traditional)		
Variables	TE	AE	EE
Constant	0.137 (0.388)	0.460 (2.079)	-8.02 (-0.262)
Age	0.7173 (0.947)	1.078 (2.277)**	1.117 (1.703)*
Education	-0.829 (-0.934)	0.125 (0.225)	-0.660 (-0.859)
Experience	0.463 (-0.457)	-0.496 (-0.783)	-0.607 (-0.691)
Household size	-0.374 (-0.205)	-1.10 (-0.965)	-0.682 (-0.432)
R^2	0.048	0.104	0.086
F	0.546	1.259	1.020

*,**,***Estimates are significant at 10 and 5% level of significance

The positive coefficient for experience and efficiency in all the efficiency indexes in improved rice farmers implies that improved rice farmers with more years of experience tend to be more economically, technically and allocatively efficient than farmers with less years of experience. However, a negative and insignificant relationship exists between household size and all the efficiency indexes.

The F-statistics in improved rice farmers is not statistically significant with TE, hence the second hypothesis which stated that the efficiency indexes of rice farmers is not affected by their socio-economic characteristics is hereby accepted . However, improved rice farmers are statistically significant with AE and EE hence the stated hypothesis is therefore rejected.

Relationship between efficiency indexes and socio economic variables under traditional rice variety: As revealed in Table 7, a significant and positive relationship exists between age and allocative and economic efficiency in the traditional rice farmers. Education has no significant relationship with all the efficiency indexes. Also, the negative coefficient for experience and efficiency indexes in Traditional rice farmers implies that farmers with more years of experience tends to be less economically, technically and allocatively efficient than farmers with less years of experience. However, experience was found to be insignificant with efficiency in traditional rice farmers. Household size was negative and has insignificant relationship with all the efficiency indexes.

In Traditional rice farmers, the F-statistics is not statistically significant with all the three efficiencies indexes (TE, AE and EE). Hence, the second hypothesis that efficiency indexes of rice farmers is not affected by their socio-economic characteristics is hereby accepted and the alternative rejected.

CONCLUSION

Findings from the study reveals that rice farmers for both technology produce at optimum level, however, there is existence of cost inefficiency effect in both improved and traditional rice farms. Also, the technical, allocative and economic efficiency effect reveals that rice produced under both technologies were inefficient. On the other hand, improved rice farmers with more years of formal school tend to be technically efficient, hence, it is recommended that traditional rice farmers should be enlightened more to enhance their production capacity.

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