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Full Length Research Paper

Technical Efficiency in Swamp and Upland Rice Production in Osun State

Olasunkanmi M. Bamiro and Janet O. Aloro

Department of Agricultural Economics Olabisi Onabanjo University Yewa Campus, Ayetoro

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This study examined the technical efficiency in both technical efficiency of upland and swamp rice production in Osun State. Proportional sampling technique was employed to collect data from 96 swamp rice farmers and 94 upland rice farmers. Descriptive statistics and stochastic production frontier were employed for data analysis. The mean technical efficiency of swamp rice farmers and upland rice farmers are 99% and 56% respectively. This indicates that the swamp rice farmers are more efficient than the upland rice farmers. Technical efficiency in swamp rice production is negatively influenced by gender, the volume of credit have inefficiency increasing effect in upland rice production. Hence, male swamp rice farmers should buck up their efficiency while the upland rice farmers should reduce the volume of credit acquired per production season.

KEY WORDS: Efficiency, Upland, Swamp, Rice, Osun, Farmers

INTRODUCTION

There are three major staple foods in the world, namely cassava, rice and wheat (Food and Agriculture Organization, 1995). Of these three crops, rice is gradually taking the lead in terms of economic importance. More than 2 billion people in the world over consume rice, as a staple food (FAO, 1995) and rice is cultivated in about 110 countries across 5 continents The largest three exporting countries are Thailand (26% Vietnam (15%) and the United states (11%). The three largest importers are Indonesia 14%, Bangladesh 4% and Brazil 3%. Nigeria is the largest producer of rice in West Africa and the second largest behind Egypt in Africa. Rice is cultivated in upland and swamp ecosystems in Nigeria. Upland rice accounts for about 30-35% of total rice while swamp rice accounts for about 25% of rice production in the country with yields as high as 2 to 8 tonnes/hectare (Idiong, 2006). Although, it ranks next to sorghum, millet, maize and cassava in order of importance with respect to area of land cultivated, it is the most important food crop in view of the total foreign exchange allocated for its importance since 1997.

In Nigeria, rice has become a major staple food in most homes today and unfortunately the domestic production of this grain has not met the demand leading to food shortages (Akpokodje, 2001 and Ogundari, 2001). The food problem in Nigeria has been exacerbated by the low level of productivity of resources used in recent time. Since Nigeria self-sufficiency in rice production started its downward trend in the 80s, declining from 98.9% in the 70s to 49.9% in the 80s then to 30% in the early 90s. It becomes necessary to meet the deficit through the importation of rice. Thus the imported rice, which was just about 600,000 tonnes in 1981 increased to one million tonnes in 1982. The West African Rice Development Association, 1993 observed that the average annual growth rate of 14.2% in rice production in Nigeria between 1973 & 1982 was due primarily to the favorable Government policy of banning rice importation in 1986. Although there was increase in the production in 1994, the average yield remained fairly closed to 1.5 tons per hectare. This mean increase in production was not due to increased productivity per unit of resources but mere expansion in hectares harvested.

As the demand for the rice continues to rise, the Nigeria government has continued to give prominence to its production in agricultural development policy and programmes. The estimated output of rice in Nigeria according to CBN (1998) grew from 2,427,000 tons in 1994 to 3,230,000tons in 1997 implying an average

Corresponding Author E-Mail: olasunkanmibamiro1999@yahoo.co.uk

growth rate of 3.0% for the period. Although this average growth rate compares fairly well with the 3.6% for all staples together, the rate was still lower than the 5.5% targeted in the 1997 to 1999 in the National Rolling Plan. This has implication for the realization of "self-sufficiency" in rice production in which rice would still have to be imported to meet domestic demands and the deficiency in rice supply could transmit to high price of rice. WARDA (1993) reported a decline in Nigeria's rice "self-sufficiency" ratio from 99.4% in 1965 to 36.7% in 1979, which further dropped to 30% in 1991. Despite the concerted efforts made to bridge the gap between production and consumption through importation, rice has become inaccessible in terms of quantity and price, to a lot of people due to the production constraint, which has resulted to low yield in production.

The low yield can be attributed to several factors such as agro climatologically problems, biological problems (i.e. problem of weed, pests and diseases), problem of input procurement and high cost of inputs, lack of credit facilities and poor price incentives, among others. According to Olakitan (1997), the key factors limiting yield in rice production include mode of land preparation, planting methods, soil fertility management, pests, diseases and weed management/control Chan and Haque (1997) also identified socio-economic and infrastructure constraints which includes capital shortages, pest, diseases and weed infestation, lack of quality seeds and other necessary inputs and poor management practices as factors that hinder productivity of upland rice.

Existing low level of productivity in food grain production reflect low level of technical, allocative and economic efficiencies. Therefore, increasing agricultural growth is an indication of appreciable growth in agricultural production process that is linked to farm profit. Hence, farm productivity and efficiency is no longer debatable but a necessity in view of food deficit being experienced in the country judged by the over reliance on food importation in recent time [7]. This is the premise upon which this study examined the technical efficiency in rice production in one of the major rice baskets state of the nation.

MATERIALS AND METHODS

The study was carried out in Osun State, Nigeria. The state is one of the few states in Nigeria that are known for rice production in Nigeria. Proportional sampling technique was employed for the data collection from the three local government areas (Oriade, Obokun and Ila) of the state that are the rice basket of the state.

Descriptive statistics was employed for the description of the socio-economic characteristics of the rice farmers while budgetary technique, profitability analysis and efficiency ratio were used to examine the cost-return structure, while the stochastic frontier production function was employed for the technical efficiency analysis.

The Stochastic Frontier Production Function

According to Ojo (2003) the production technology of the farmers assumes to be specified by the Cobb –Douglas frontier production function Tadese and Krishnamoorthy (1997) that is defined by

$$\ln Y_1 = \ln \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + Vi - Ui$$

Where;
Y = Rice output in Kg
X_1 = Hectares of land cultivated with rice
X_2 = Seed planted (kg)
X_3 = Hired labour (man days)
X_4 = Household labour (mandays)
X_5 = Quantity of fertilizer (kg)
X_6 = Cost of other intermediate materials (#)
Vi = Random errors
Technical inefficiency effects, Ui is defined by;

$$Ui = \beta_0 + \beta_1 Z_i + \beta_2 Z_2 i + \beta_3 Z_3 i + \beta_4 Z_{4i} + \beta_5 Z_5 i + \beta_6 Z_6 i + \beta_7 Z_7 i + \beta_8 Z_8 i$$

Where;

Z_1 = Farmers age in years
Z_2 = Farmers sex
Z_3 = Years of schooling
Z_4 = Farming experience of farmers (years)
Z_5 = Other occupation of the farmers
Z_6 = Religion
Z_7 = Total hectares of rice plantation
Z_8 = Credit access

These were included in the model to indicate their possible influence on the technical efficiencies of the farmers. The βs and δs are scalar parameters that were estimated. The variances of the random errors, δ_v^2 and that of the technical inefficiency effects δ_u^2, and the overall variance of the model δ^2 are related thus: $\delta^2 = \delta_v^2 + \delta_u^2$ and the ratio $\gamma = \delta_u^2/\delta_v^2$, measures the frontier which can be attributed to technical inefficiency (Battese and Corra 1977). The estimates for all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained, using the program frontier version 4.1(Battese and Coelli 1995).

Two different models, Ordinary Least Square (OLS) and the Maximum Likelihood Estimate (MLE) were estimated. The OLS is a special case of the stochastic frontier production function in which there is restriction and the total variation of output from the frontier output due to technical inefficiency is zero, that is, $\gamma = 0$. The MLE on the other hand, is the general model where there is no restriction, hence $\gamma \neq 0$. The two models were

Table 1: Socio-economic characteristics of rice farmerns in Osun State, Nigeria

Variables	Frequency	Percentage
Age range		
Below 40	29	29.6
40-49	45	46
50-59	17	17.3
60 and above	7	7.1
Educational status		
No formal education	5	5.1
Primary	45	45.9
Secondary	5	5.1
Tertiary	43	43.9
Sex		
Male	57	58.2
Female	41	41.8
Marital status		
Single	3	3.1
Married	91	92.8
Widowed	2	2.0
Divorced	2	2.0
Household size		
1-3	3	3.1
4-6	31	31.6
7-9	50	51.0
10 or more	14	14.3
Farming experience		
1-10	31	31.6
11-20	51	52.0
21-30	10	10.2
Above 30	6	6.1
Major occupation		
Rice farming	43	43.1
Civil service	28	28.6
Trading	23	23.5
Fishing	4	4.1
Sources of fund		
Bank	3	3.1
Cooperative society	51	52
Money lender	23	23.5
Friends and relatives	20	20.4

Source: Computed from field survey, 2007.

compared for the presence of technical inefficiency effects, using the generalized likelihood ratio test.

RESULT AND DISCUSSION

Socio-economic characteristics of rice farmers in Osun State

The results of the analysis of socio-economic characteristics of rice farmers in Osun State are presented in Table 1. The result shows that the greatest proportion of the rice farmers falls between active working age of below 40 and 50 years. More males than females (about 58% to 42%) and more married couples than single (93% to 3%) were involved in rice production. This finding agrees with that of Aihonsu (2002). The high levels of men and married couple involvement in rice production may not be unconnected with high demand of labour for bush clearing, weeding, planting and scaring of birds; and the possibility of supply of the required labour at the family level. In the same vein, farmers with large household size (7->10) are more involved in rice production for the same reason of meeting the labour requirement of rice production. Most of the respondents (93%) have at least primary school education which in no small way would aid effective performance in technology adoption and fertilizer and pesticide application. A large percentage (43%) of the respondents has farming as their main occupation while all other respondents are part-time farmers, whose main occupations are civil service, trading and fishing. A large chunk of the farmers have 11-20 years' experience in rice production and a

Table 2: Ordinary Least Square and Maximum Likelihood Estimator and Inefficiency Function for Upland Rice in Osun State

Variables	OLS	MLE
Constant	6.06(11.91)	6.13(6.14)
Land	0.653(8.167)*	0.665(2.45)*
Hired labour	0.185(2.363)*	0.154(0.400)
Family labour	-0.185(1.54)***	-0.126(-0.190)
Seed	0.303(4.38)*	0.291(0.407)
Fertilizer	0.0126(-0.257)	-0.0426(0.0510)
Herbicide	0.0176(1.05)	0.0180(0.533)
Tractor	0.00648(1.072)	-0.00606(0.419)
Inefficiency Function		
Constant		0.0245(0.0242)
Age		0.00587(0.164)
Gender		0.0933(0.211)
Education		-0.00740(-0.147)
Experience		0.00653(-0.195)
Part – time		0.0139(-0.0153)
Farm size		0.00858(0.0844)
Credit		0.0885(3.161)*
Diagnosis statistics		
Sigma Square	0.946	
Gamma		0.00252(0.0301)
Log of likelihood Function	-18.87	-15.66
LR test		6.424

Source: Computed from survey data, 2007
Note that the variables in parentheses are the T-Values
*** Signifies 10% significant level
** Signifies 5 % significant level
* Signifies 1% significant level

handful (6%) has acquired rice production experience for more than 30 years. The result in the Table further revealed that the main source of capital of the rice farmer is the cooperative society; about 52% of the rice farmers obtained their take off capital and fund for expansion from the cooperative society. On the other hand an insignificant proportion (3%) of the rice farmer obtained credit facility from commercial banks. This result is in line with the findings of Bolaji (1990), that cooperative society is a veritable tool for capital formation and agricultural development

Determinants of Technical Efficiency in Rice Production

The ordinary least square (OLS) and the maximum likelihood estimates (MLE) of the stochastic frontier production function for swamp and upland rice production in the study area are presented in Tables 3 and 4. There was presence of technical inefficiency effects in rice production in the study as confirmed by a test of hypothesis for the presence of inefficiency effects, using the generalized likelihood ratio test. The null hypothesis of no inefficiency effect in swamp and upland rice production, $\gamma = 0$ was strongly rejected. Thus OLS model was not an adequate representation of the data. Hence, MLE model was the preferred model for further econometric and economic analysis. The generalized likelihood ratio (LR) test reported in Tables 3 and 4 are highly significant. This suggests that there is presence of one sided error component. It means the effect of technical inefficiency is significant and a classical regression model of production function is an inadequate representation of the data. The determinants of the swamp and upland rice production and technical efficiency estimates are presented as follows:

Determinants of Technical Efficiency in Upland Rice Production

The coefficients of land, hired labour and seed for upland rice are statistically significant at 1 percent level in the OLS estimation while all other variables, hired labour, herbicide, seed, fertilizer, herbicide tractor have no significant effect on upland rice production but the positive sign of the coefficients indicates that the use of these inputs will enhance upland rice production. In (MLE), the coefficient of land is the only statistically significant variable and it is significant at 1% probability level. The inefficiency function shows that credit size is the only factor that influences inefficiency. The volume of credit is significant at 1 percent and positively related to

Table 3: Ordinary Least Square and Maximum Likelihood Estimates and Inefficiency Function for Swamp Rice in Osun State

Variables	OLS	MLE
Constant	-0.219(-0.777)	0.102(0.0278)
Land	0.857(17.23)*	0.871(17.09)*
Hired labour	0.194(2.532)	0.299(3.881)*
Family labour	-0.902(-1.678)**	-0.143(2.789)*
Seed	0.0730(1.628)***	0.744(1.759)**
Fertilizer	0.0280(1.834)**	0.0201(1.553)
Herbicide	-0.198(-2.511)*	-0.0238(-3.413)*
Tractor	0.0645(1.944)**	0.00821(2.763)*
Inefficiency		
Constant		0.7006(0.0190)
Age		-0.0022(-1.048)
Gender		-0.0613(-1.895)**
Education		-0.00385(-1.067)
Experience		-0.00227(-1.028)
Part – time		0.100(3.036)
Farm size		0.0087(1.192)
Credit		-0.0425(-1.245)
Diagnosis statistics		
Sigma Square		0.0196(6.955)
Gamma		0.339(0.104)
Log of likelihood		
Function	42.78	51.382
LR test		17.191

Source: Computed from survey data, 2007

Table 4: Technical efficiency estimates of the upland and swamp rice farms

UPLAND RICE PRODUCTION			SWAMP RICE PRODUCTION		
Class interval	**Frequency**	**Percentage**	**Class interval**	**Frequency**	**Percentage**
Less than 80	4	4.1	Less than 50	7	7.4
80 – 84	14	14.7	50 – 54	41	43.6
85 – 89	23	23.9	55 – 59	27	28.7
90 – 94	24	25	60 – 64	5	16.0
95 – 99	21	32	65 – 69	3	3.2
			70 and above	1	1.1
Total	**96**	**100**	**Total**	**94**	**100**

Source: Computed from survey data, 2007

Minimum T.E=77% Minimum TE = 48%
Maximum T.E=99% Maximum TE = 71%
Mean Efficiency = 91% Mean Efficiency = 56%

inefficiency. This indicates that volume of credit has inefficiency increasing effect. This is contrary to expectation, however, it is plausible because availability of credit to farmers at awkward time, bearing in mind, the timeliness of agricultural production could have rendered the fund useless for the purpose for which it was borrowed and thus reduced the resource use efficiency in rice production.

Determinants of Technical Efficiency in Swamp Rice Production

All the explanatory variables included in the model with the exception of fertilizer have significant influence on swamp rice production. Land, herbicide, tractor hiring and family and hired labour are significant at 1 percent probability level while seed is significant at 5 percent probability level. Land, hired labour and tractor hiring and seed have positive influence on rice production, which implies that swamp rice output increases with increase in these factors. These results agree with the findings of Rahman et al (2008). While family labour and herbicides have negative influence on swamp rice production. This result is in consonance with the findings of Idiong (2006) and Ogundari (2001). The decrease in output of rice production with the application of herbicides might not be

unconnected with the fact that rice and weeds in rice plots belong to the same graminea family, which renders rice susceptible to herbicides attack except selective herbicide is applied. The inefficiency function shows that gender has negative and significant influence on inefficiency of the farmers. This implies that female rice farmers are more efficient than their male counterparts in swamp rice production.

Technical efficiency estimates of swamp rice production

Predicted technical efficiencies ranges between 48% and 71%. The result shows that about 44% of the sampled swamp rice farmers have technical efficiency between 50 and 54% operating averagely close to the technology frontier. The mean technical efficiency of the entire swamp rice farm was estimated at 56%. This signifies that there exists a 44% potential for swamp rice farmers to increase their production by increasing the level of resources and technology.

Technical efficiency estimates of upland rice production

Predicted technical efficiencies for upland rice production ranges between 77% and 99% as shown in Table 4. The result shows that about 32% of the sampled uplands rice farmers have technical efficiencies greater that 94% operating close to the technology frontier. About 25% of the sampled upland rice farmers have technical efficiency that is between 90 and 94%. About 24% of the sampled upland rice farms have technical efficiency that is between 85% and 90%. The mean technical efficiency of the entire upland rice farm was estimated as 91% indicating substantial efficiencies in upland rice production. This signifies that there exists 9% potential for upland rice farmer to increase their production vis–a–vis their income at the existing level of resources and technology. This suggests that by operating at full technical efficiency level, upland rice farmers can increase their production by an average of 9% with the available farm resources and technology.

Comparative analysis of technical efficiency of upland and swamp rice production

The mean technical efficiencies in upland rice production and swamp rice production are 91% and 56% respectively. While in the short run, there is a scope for increasing rice production by about 9% in upland rice production by adopting the technology and techniques used by the best practiced upland rice farm and thus increase their income at the existing level of resources and technology, there exists as high as 44% potential for swamp rice farmers to increase their production vis-a- vis their income at the existing level of resources and technology. This is an indicator that the upland rice farmers are more technically efficient in the utilization of resources than their counterparts that are involved in swamp rice production.

CONCLUSION

This study examined the technical efficiency in both upland and swamp rice production in Osun State. Proportional sampling technique was employed to collect data from 96 swamp rice farmers and 94 upland rice farmers. Descriptive statistics and stochastic production frontier were employed for data analysis. The result shows that the greatest proportion of the rice farmers falls between active working age of below 40 and 50 years. More males than females were involved in rice production. Most of the rice farmers are all literate and in most cases had other jobs apart from rice production. Most of the farmers started their production through loans from cooperative societies.

Land, hired labour, tractor hiring and seed have positive and significant influence on rice production, while family labour and herbicides exerts negative and significant influence on swamp rice production. On the other hand, land is the only resource that significantly influenced the upland rice production in the state. Hence farmers should increase the utilization of inputs that have positive effect on rice production and reduce those that have negative influence. Technical efficiency in swamp rice production and upland rice production are determined by gender and volume of credit respectively. Technical efficiency in upland rice production ranges between 77and 99% with mean technical efficiency of 91% while the technical efficiency of the swamp rice production is between 48% and 77% with mean technical efficiency of 56%. This is a proof that the upland rice farmers are more technically efficient than their counterparts planting swamp rice. The upland rice farmers should reduce the volume of credit acquired per production season, since volume of credit has inefficiency increasing effect while the male farmers in swamp rice production should buck up to be at least as efficient as their female counterparts.

REFERENCES

Ahionsu, JOY (2002). Compartive Economic Analysis of Swamp and Rice in Ogun State" Unpublished Ph.D thesis, Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife.

Akpokodje, G, Lancon, F, Erenstein O (2001). Nigeria's Rice Economy: State of the Art, the Nigerian Rice Economy in a Competitive World. Constraints Opportunities and Strategic Choices". Final Report Presented to West Africa Rice Development Association (WARDA) Bouake, Cote d"Ivoire, p. 55.

Battese, GE, Coelli, T (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data, Empirical

Economics, 20: 325-332.
Battese, GE, Corra, GS (1977). Estimation of Production Function Model with Application to the Pictorial Zone of Eastern Australia". Australian J. Agric. Econ., 21: 169-179
Bolaji, AA (1990). The use of Agricultural Credit as an Approach to small farmer Unpublished M.Sc. Dissertation, Department of Agricultural Economics, University of Ibadan.
Central Bank of Nigeria CBN (1998). Central Bank of Nigeria Annual Report and Statement of Account for the year ended 31st December 1997.
Central Bank of Nigeria CBN (2003) Central Bank of Nigeria Annual Report and Statement of Account for the year ended 31st December 2002.
Chan, R, Haque, J (1997). Sustainability of Rice – Wheat crop system in Indo – Gangetic region. Economic and Political weekly, 32(13):26 – 30.
Idiong, IC (2006). Evaluation of Technical, Allocative and Economic Efficiencies in Rice Production Systems in Cross River State, Nigeria. Unpublished Ph.D Dissertation. Micheal Okpara University of Agriculture, Umudike.
Ogundari, K (2006). Determinants of Profit Efficiency among Small Scale Rice Farmers in Nigeria: a profit function approach. Paper presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia, p. 27
Ojo, SO (2003). Factor Productivities in Maize Production in Ondo State, Nigeria Applied Tropical Agriculture, 15 (1): 57-63.
Olakitan, KA (1997) Effect of rates of application of Constar 25EC on yield and yield component of rice (Oryza sativa Unpublished B. Agricultural Dissertation Department of crop year, Production, Ogun State University, Ago-Iwoye.
Onyeweanku, CE, Ohajiaya, DU (2002). Gender and Relative Efficiency in Rice Production in Ebonyi State, Nigeria. J. Agric. And Sustainable Environ., (3): 384-392.
Rahman, S, Rahman, M (2008). Impact of land Fragmentation and Resource Ownership on Productivity and Effficiency: The case of Rice Producers in Bangladesh. Land Use Policy, 26: 95-103.
Tadesse, B, Krishnamoorthy, S (1997). Technical Efficiency in Paddy farms of Tamil Nadu-An analysis based on farm size and ecological zone. Agric. Econ., 16: 185-192.
WARDA (1993**).** Rice Trends in Sub-Saharan Africa (A synthesis of statistical gains in Nigeria) IITA Research Briefs, 9(3): 487.