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Full Length Research Paper

Effects of off-farm work on the technical efficiency of rice farmers in Enugu State, Nigeria

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This study investigated the effects of off-farm work on technical efficiency of rice farmers in Enugu State, Nigeria. Ninety respondents were selected using multi-stage sampling technique. Data for the study were collected by the use of well structured questionnaire. Stochastic production frontier model was used to analyse the data. Results showed that technical efficiency scores for the farmers ranged from 0.579 to 1.000 and 0.606 to 1.000 for the rice farmers without and with off-farm work respectively. The average efficiencies are 0.964 and 0.871 for rice farmers without and with off-farm work, respectively. This suggests that off-farm work has a negative effect on farmers' technical efficiency. The result of the student t-test conducted at 5% significance level showed that there is a significant difference in the mean technical efficiency of the two groups of rice farmers. Finally, the study recommended that government should come up with policies that will make agriculture more lucrative and attractive so as to encourage farmers to focus on agricultural production so that they do not seek off-farm employment that can negatively affect their technical efficiency.

Key words: Technical efficiency, off-farm work, rice farmers, stochastic production frontier model.

INTRODUCTION

The struggle for food has become extremely difficult for the 240 million people of West Africa of which one of every three is a Nigerian (West Africa Rice Development Association - WARDA, 2002). Rice (*Oryza sativa*) is the staple food of just about half of the world's population (International Rice Research Institute - IRRI, 1997). It has conventionally been an essential food commodity for some populations in sub-Saharan Africa (SSA), and West Africa in particular. The demand for rice has been growing at a much faster rate in Nigeria than in other West African countries since the mid 1970s (WARDA, 2001). For instance, during the 1960s, Nigeria had the least per-capita annual consumption of rice in the sub-region (average of 3 kg). Since then, Nigeria's per capita consumption levels have increased appreciably at 7.3% per annum (Ogundele and Okoruwa, 2006). Subsequently, per-capita consumption during the 1980s averaged 18 kg and reached 22 kg in 1995-1999. In a bid to respond to the increased per capita consumption of rice in Nigeria, domestic production significantly increased, averaging 9.3% per annum (Ogundele and Okoruwa, 2006). Nevertheless, local production of this commodity has been insufficient and unable to bridge the growing demand-supply gap. In an apparent move to address the demand-supply gap for rice, governments have at different times come up with policies and programmes. Though, these policies according to WARDA (2001) have been inconsistent due mostly to oscillating import tariffs and import restrictions, Nigeria has relied a great deal on imported rice to meet her consumption needs and has become the World's largest importer of rice (WARDA, 2003). According to Okorji and Onwuka (1994), the rice import bill for Nigeria was ₦123.61 million in 1980 and has from that time continued to increase. That Nigeria has remained a net importer of rice with well over ₦150.15 billion spent annually (FOS, 2000) is suggestive of the declining self-sufficiency. This

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constitutes an enormous drain on Nigeria's foreign reserve and a key bottleneck in the balance of payments (Egbuna, 2003).

If Government will achieve her goal of self sufficiency in rice production then, the level of farmers' productivity must be increased. This can be increased either by adopting improved technologies or increasing efficiency of the farmers in their use of available resources. However, considering the fact that most of the farmers in developing countries are resource poor farmers adopting improved technologies may be difficult and so efficiency in the use of resources becomes a better option and a very important factor in increasing productivity (Ali and Chandry, 1990). Moreover, in recent times, farm families in general and small farm operators in particular have been taking up off-farm employment in increasing numbers. The significance of off-farm work has also been recognized in many countries. It is a generally held belief that off-farm employment provides a risk management tool to lessen the income variability associated with the farm household (El-Osta and Morehart, 2008; El-Osta et al., 2007). It is likely that the increased dependence on off-farm employment affects the allocation of family labour, and consequently exerts an influence on farm productivity. Numerous studies (Obwona, 2006; Ogundele and Okoruwa, 2006; Tijani, 2006; Al-hassan, 2008; Nwaru and Iheke, 2010; Onoja and Achike, 2010) have attempted to investigate technical efficiencies of farmers in developing countries including Nigeria since determining the efficiency status of farmers is imperative for policy purposes. However, few of these studies took account of the effects of off-farm work on the technical efficiency of these farmers. This study, then, becomes vital in examining the influence of off-farm work on technical efficiency of rice farmers in Enugu State, Nigeria. This is in view of the fact that technical efficiency examined without taking into account the influence of off-farm work is not the same as that examined considering the influence of off-farm work. Specifically, the objectives of this study are to:

(i) Determine and compare the technical efficiency of rice farmers (with and without off-farm work).
(ii) Identify factors that affect technical efficiency of the two groups of rice farmers.

Hypothesis

There is no significant difference in the technical efficiency of rice farmers with and without off-farm work.

METHODOLOGY

Study area

The study area was Enugu State, Nigeria. The State lies approximately between latitudes 5°56' N and 7°05' N of the equator and longitudes 6°53 'E and 7°55'E of the Greenwich Meridian (Anyadike, 2002). The State is bordered to the east by Ebonyi State, to the west by Anambra State, to the north by Benue and Kogi States and to the south by Abia State. The state has a land area of about 8,022.95 km^2 with seventeen local government areas (LGAs) (Enugu State Agricultural Development Programme - ENADEP, 2008) and a population of about 3,257,298 persons (NPC, 2006). The major agricultural practice in the State is crop farming. Though, animals are reared in all parts of the State in small numbers, the main food crops grown include: rice, maize, yam, cassava, groundnut, cowpea, melon, vegetables, sweet potato and cocoyam. The common tree crops grown are Citrus spp, oil palm, pears, mango and cashew (NAERLS and PCU, 2006). According to ENADEP (2008), Enugu State is delineated into three major agricultural zones, namely:

- North Zone comprising Nsukka, Igbo-Eze North, Igbo-Eze South, Igbo-Etiti, Udenu and Uzo-Uwani LGAs.
- East Zone comprising Isi- Uzo, Enugu East, Enugu North, Enugu South, Nkanu East and Nkanu West LGAs.
- West Zone comprising Awgu, Aninri, Oji River, Ezeagu and Udi LGAs.

Sampling procedure

Multi-stage sampling technique was used in selecting ninety respondents for the study. Firstly, two agricultural zones (North zone and West zone) were purposively selected due to the predominance of rice production in the area. The second stage involved a purposive selection of two local government areas namely Aninri (in West zone) and Uzo-Uwani (in North zone) also due to the predominance of rice production in these areas. Thirdly, one community was randomly selected from each of the selected local government areas giving a total of two communities, Oduma (in Aninri) and Adani (in Uzo-Uwani). The fourth stage involved stratification of the farmers (in the two communities) into rice farmers with and without off-farm work. The last stage involved the random selection of rice farmers from each stratum, of which 59 was selected from the stratum of rice farmers without off-farm work and 31 from the stratum of rice farmers with off-farm work.

Data collection

Data for the study were collected mainly from primary source. Data were collected by the use of structured questionnaire which was administered by trained enumerators. Both qualitative and quantitative information on the relevant variables were collected such as the production and cost data in rice production, socio-economic characteristics of the farmers, engagement in off-farm work and income sources.

Data analysis

Data collected were analysed using descriptive statistics (such as means, frequencies, percentages and standard deviations) and stochastic production frontier model in order to achieve the specific objectives.

Model specification

Stochastic frontier production function

This study employed a stochastic frontier model following the specification proposed by Battese et al. (1997) and Chang and Wen (2011). The stochastic frontier model not only allows for heterogeneity in the mean of the inefficiency term to investigate inefficiency effects, but also allows for heterogeneity in the noise component to investigate risk effects. It is given by the equation:

$$y_i = x_i \beta + v_i - u_i \quad (1)$$

where,

y_i is the logarithm of the production yield;
Xiß is a suitable production function such as the Cobb-Douglas or translog;
x_i is the logarithm of the production inputs;
β is a (k × 1) vector of unknown parameter (coefficients) that characterize the production frontier;
u_i is the inefficiency term which follows a truncated-normal distribution with mean $\bar{u}_i$ and variance σ_u^2 as specified below:

$$u_i \sim N + (\bar{u}_i, \sigma_u^2) \quad (2)$$

$$\bar{u}_i = w_i \alpha$$

where:

w_i = vector of exogenous (explanatory) variables like socio economic characteristics that have influences on the mean value of production inefficiency. They include:

w_1 = average number of farmers in each cooperative team (number);
w_2 = family size (number);
w_3 = age (years);
w_4 = education (number of years);
w_5 = extension services (number of visits);
α = vector of unknown parameters (coefficients) associated with the mean of the production inefficiency;
v_i = the noise component.

RESULTS AND DISCUSSION

Estimation of the stochastic production frontier model

The parameters of the stochastic production frontier model were estimated simultaneously using the linear estimation procedure of the maximum likelihood estimation available in the statistical software STATA 11 and the result is presented in Table 2. The upper section of the table represents coefficients of the production function, while the lower section represents coefficients of the production inefficiency function.

Estimation results for production function

The result of the maximum likelihood estimates (MLE) of the Cobb-Douglas model is presented in Table 2. Estimated output elasticities for all the inputs all differed from zero at the 1% significance level for the two groups of rice farmers except hired labour which has significance level of 10% for rice farmers without off-farm work. For the group of rice farmers without off-farm work, the elasticity for depreciated value of equipment is the largest (0.172). This means a 10% increase in the depreciated value of equipment used will give rise to a 1.72% increase in output. This agrees with the findings of Chang and Wen (2011) who found that machinery use had the largest elasticity. This is followed by the use of agrochemical (-0.113). The relationship seem to be negative, it could be that the farmers are not applying it in the right quantity required. So, extension workers should educate the farmers on the proper application of agrochemicals. This is followed by farm size (-0.107). This means that a 10% increase in farm size will decrease output by 1.07%. The negative influence of farm size could be as a result of poor or lack of education among the rice farmers, a condition necessary to bring out the efficiency of land use and other resources normally employed in rice farming. The next on the row is family labour (-0.027) which has a negative relationship with output. A possible explanation of this may be that the quality of family labour used is not good enough for example using children to do the work that adults should effectively handle. This is followed by seed (0.017) and fertilizer (0.011) which had a positive influence on the output as expected. Hired labour has the least elasticity of 0.002. The higher elasticity of family labour than that of hired labour for rice farmers without off-farm income is consistent with the findings of Chang and Wen (2011) and Audibert (1997).

For the other group of rice farmers with off-farm work, depreciated value of equipment has the largest elasticity (-0.265) just like their counterpart. The negative influence of this variable could be that this group because of their engagement in off-farm work pay little attention to farm management and lack good knowledge regarding the use of inputs. This is followed by seed with elasticity of 0.162. The reason for seed coming second instead of fifth as in the case of their counterpart could be that this group use the additional income from off-farm work to purchase very high quality seeds. The third is hired labour with elasticity of 0.058. This is not surprising due to the fact that if this group engages in off-farm work, they will need to engage the services of very competent hired labour to take care

Table 1. Summary statistics of variables for the analysis.

Variable	Unit	Mean	Std. Dev.	Minimum	Maximum
L noutput (Y)	Kg	8.37	0.72	7.31	10.31
Ln seed	Kg	5.58	0.73	4.61	7.60
Ln fertilizer	Kg	5.68	1.80	4.61	7.72
Ln farm size	Ha	0.27	0.76	-1.14	2.30
Ln family labour	Man days	5.26	5.31	3.18	7.54
Ln hired labour	Man days	5.76	2.85	4.63	8.40
Ln agrochemicals	Naira	9.73	0.69	8.31	11.50
Ln equipment	Naira	9.95	0.70	7.91	11.79
Average No Association	Number	20.99	16.96	10	82
Age	Years	49.08	10.80	23	75
Household size	Number	6.58	2.54	2	15
Educational level	Years	6.43	6.27	0	20
Extension access	Number of visits/year	2.59	0.85	2	5

$$\text{NB: AverageNoAssociation} = \frac{\text{Total number of people in the association(s)}}{\text{Number of association(s)}}$$

Source: Field survey (2012).

of most of their production activities. The fourth on the row is agrochemical having elasticity of -0.043. The negative sign as have earlier been stated could be that the agrochemical is not being applied correctly. The next on the row is farm size (0.033) and family labour (0.018). The variable with the least elasticity for this group of rice farmers with off-farm work is fertilizer (0.014). Table 1 shows the summary statistics of the variables used in the analysis.

Estimation results for technical inefficiency function

The results of technical inefficiency effects are also presented in the lower part of Table 2. For rice farmers without off-farm work, average number of associations, age, education and extension access significantly and positively influenced technical inefficiency effects. This is surprising. The explanation may be that the extension agents and the association they belong to are not bringing relevant and up-to-date information to the farmers or the farmers are not making use of the information provided to them. This is similar with the result of Tijani (2006) who found extension service to have negative relationship with efficiency.

For rice farmers with off-farm work, age and extension access significantly and positively influenced technical inefficiency effects. The explanation may be that the older farmers lack the strength to carry out some of the activities and may tend to be less open to innovative technologies that could boost their efficiency. This result agrees with the findings of Khai and Yabe (2011) who found that age had negative relationship with technical efficiency. The variable 'household size' significantly and negatively influenced technical inefficiency effects when compared with the distributions of the technical efficiency scores between the two groups of rice farmers.

Table 3 reports the sample statistics of technical efficiency in terms of percentiles for the two groups of rice farmers. Technical efficiency scores for the farmers ranged from 0.579 to 1.000 and 0.606 to 1.000 for the rice farmers without and with off-farm work respectively. A negative impact of off-farm work on farm efficiency was found in previous studies, such as Kumbhakar et al. (1989), Fernandez-Cornejo (1992), Goodwin and Mishra (2004) and Chang and Wen (2011). Our empirical findings support this conclusion since the average efficiencies are 0.964 and 0.871 for rice farmers without and with off-farm work, respectively. The average efficiency scores of 0.964 and 0.871 for rice farmers without and with off-farm work imply a technical inefficiency of 0.037 (1-0.964/0.964) and 0.148 (1-0.871/0.871) respectively. The economic interpretation of these figures is that an average farmer in the study area requires approximately 4% (for rice farmers without off-farm work) and 15% (for rice farmers with off-farm work) of more resources to produce same output (or meet the same objectives) as an efficient rice farmer on the frontier.

A student t-test was conducted to test the equality of the sample mean between the two groups of rice farmers. The t_{cal} value (3.423) was greater than the t_{tab} value (1.289) at 5% level of significance and hence the null hypothesis which states that there is no significant difference in the mean of the two groups was rejected.

Test of hypothesis

There is no significant difference in the technical

Table 2. Stochastic production frontier estimates of determinants of technical inefficiency of rice farmers in Enugu State.

Variable	Without off-farm work		With off-farm work	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Ln seed	0.017***	0.013	0.162***	0.000
Ln fertilizer	0.011***	0.000	0.014***	0.000
Ln farm size	-0.107***	0.012	0.033***	0.000
Ln family labour	-0.027***	0.000	0.018***	0.000
Ln hired labour	0.002*	0.000	0.058***	0.000
Ln agrochemical	-0.113***	0.006	-0.043***	0.000
Ln equipment	0.172***	0.002	-0.265***	0.000
Constant	2.095***	0.111	9.964***	0.000
Inefficiency function				
AvgNoAsso	0.646***	0.111	0.007	0.007
Age	0.328***	0.641	0.159***	0.602
Household size	0.092	0.152	-0.970***	0.340
Educational level	3.838***	0.648	0.391	0.374
Extension access	3.144***	0.988	4.727***	1.438
Constant	-41.256***	5.830	-14.458***	3.041
Log-likelihood	82.634		34.722	

*, *** indicate significance level of 10% and 1% respectively.
Note: A negative sign of the parameters in the inefficiency function means that the associated variable has a positive effect on technical efficiency, and vice versa.
Source: Field survey (2012).

Table 3. Distributions of technical efficiency.

Variable	Without off-farm work	With off-farm work
Mean	0.964	0.871
Minimum	0.579	0.606
Maximum	1.000	1.000
Std. Deviation	0.092	0.124
Percentile (%)		
1	0.579	0.606
5	0.668	0.621
10	0.869	0.727
25	0.994	0.759
50	0.999	0.889
75	0.999	0.999
95	1.000	1.000

Source: Field survey (2012).

efficiency of rice farmers with and without off-farm work. The result of the student t-test conducted to test the equality of the sample mean between the two groups of rice farmers is presented in Table 4. The t_{cal} value (3.423) was greater than the t_{tab} value (1.289) at 5% level of significance and hence the null hypothesis was rejected.

CONCLUSION/RECOMMENDATION

This study was carried out to ascertain the effect of off-farm work on technical efficiency and production risk among rice farmers in Enugu State, Nigeria. Comparisons were made between the technical efficiency

Table 4. T-test result.

Null hypothesis	t-calculated	t-tabulated (0.05)	Decision
H_0: $TE_1 = TE_2$	3.423	1.289	Reject H_0

Subscripts 1 and 2 refer to rice farmers with and without off-farm work respectively.

of rice farmers who engaged in off-farm work and rice farmers who did not engage in off-farm work. The following conclusion was drawn: there is substantial difference in the mean levels of technical efficiency between rice farmers with and without off-farm work. Hence, off-farm work can be said to negatively affect technical efficiency of the rice farmers in the study area. The study recommends that government should come up with policies that will make agriculture more lucrative and attractive so as to encourage farmers to focus on agricultural production so that they do not seek off-farm employment that can negatively affect their technical efficiency.

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