Determinants of Technical Inefficiency and Rice Production Risk in Enugu State, Nigeria

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ABSTRACT
The study investigated the factors that influenced technical inefficiency and rice production risk among two groups of rice farmers (those with and without off-farm work) in Enugu State, Nigeria. The specific objectives of this study are to: estimate the input-output elasticities of rice production between the two groups of rice farmers and ascertain the factors that influence technical efficiency and production risks between the two groups of rice farmers. Ninety (90) rice farmers were selected for the study using multi-stage sampling technique. Data for the study were collected using structured questionnaire. Stochastic production frontier model was used to analyse the data. The results showed that extension access and age significantly and positively influenced technical inefficiency effects for the two groups of rice farmers. Also, for farmers without off-farm work, family labour (1.287) has a positive and significant effect (p<0.01) on production risk, implying that family labour is a risk increasing factor. Depreciated value of equipment (-12.255) used has a negative and significant effect (p<0.01) on production risk which indicates that investment on equipment will decrease the production risk in rice production. It can be concluded from the results of the study that a risk averse rice farmer in the study area is expected to use more of equipment and less of family labour while age and extension access will increase technical inefficiency. Hence, the study recommended that activities of extension agents should be investigated further given the positive influence it has on technical inefficiency. Also, farmers should be encouraged to invest in equipment as this decreases production risk in rice production.

Key words: technical, inefficiency, production, risk, rice.

INTRODUCTION

Rice is the primary staple food for more than half of the world's population – over 3.5 billion individuals depend on rice for more than 20% of their daily calories – with Asia, South America and Sub-Saharan Africa the largest consuming regions (KPMG, 2019). In Sub-Saharan Africa, rice is the fastest growing staple food, with annual per capita consumption of 27kg/year (KPMG, 2019).

In Nigeria its consumption is growing particularly among urban dwellers with a consumption per capita of 32kg (PWC, 2018). Domestic production of this commodity has been inadequate and unable to keep pace with the increasing demand. Only about 57% of the 6.7 million metric tonnes of rice consumed in Nigeria annually is locally produced, leading to a supply deficit of about 3 million metric tonnes (Food and Agriculture Organization, FAO, 2021). Government has made several efforts to make the country self-sufficient in rice production but unfortunately, this has not yielded the desired results and as a result the country has resorted to importation of the commodity. This constitutes a huge drain in the country's foreign reserve. If Government will achieve her goal of self-sufficiency in rice production, then, the level of farmers' productivity must be increased. This can be achieved either by adopting improved technologies or increasing efficiency of the farmers in the 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).

Numerous studies (Ogundele and Okoruwa 2006; Tijani 2006; Al-hassan 2008; Nwaru and Iheke 2010, Onoja and Achike 2010) have made efforts to examine technical efficiencies of farmers in developing countries including Nigeria since knowledge of the efficiency status of farmers is very significant in making policy decisions. However, not much study has attempted to investigate the factors that affect the technical efficiency of rice farmers especially in Enugu State which is one of the major rice producing States in South East Nigeria (Ikenwa, 2019). Moreover, issues of risk and farmers' responses to it, especially when it has become a fact that economic units make their decisions under uncertainty is not well documented. It should be noted that risk not only influences production output but also producers' behaviour, especially regarding input use. If risk mitigation plays a major role in decision-making, then a farm's technical efficiency score may change considerably.

Consequently, technical efficiency assessment considering the farmer's response to uncertainty is not the same in a situation where no effect of risk on input-use decisions is considered. Hence, when uncertainty is present, the theoretical framework for studying technical efficiency should be comprehensive with regards to risk and how farmers' respond to it. In this study, production risk is believed to be significant factor that influences production decisions of farmers.

Furthermore, it has been observed that the number of farm families taking up off-farm work in Nigeria has been increasing in recent times. Several studies exist which try to elucidate the reasons for this trend. Lanjouw (1999) pointed out that the reasons include declining farm incomes and the need to insure against agricultural production risk. Not very much attention has been given to estimating the relative efficiency of rice farmers who take up off-farm work viz a viz their counterpart who do not especially in Nigeria. While there is an increasing awareness that part-time farming is becoming an essential part of Nigerian agriculture, these farms are also expected to have the most staying power since they do not depend exclusively on farm income for their viability. Therefore, a study of this nature which is intended to examine the factors that influence the technical inefficiency and production risks of rice farmers in Enugu State is apt as this will guide policy makers on ways of increasing rice production in the country. Specifically, the objectives of this study are to:

i. estimate the input-output elasticities of rice production between the two groups of rice farmers (those with and without off-farm work).

ii. ascertain the factors that influence technical efficiency between the two groups of rice farmers and

iii. ascertain the factors that influence production risks between the two groups of rice farmers.

Hypothesis

Ho: Socio-economic characteristics do not significantly influence the technical inefficiency of the two groups of farmers

Ha: Socio-economic characteristics significantly influence the technical inefficiency of the two groups of farmers.

METHODOLOGY

The study area was Enugu State, Nigeria. The State lies approximately between latitudes $5^0 56'$ N and $7^0 05'$ N of the equator and longitudes $6^0 53'$ E and $7^0 55'$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 8,022.95km^2 with seventeen local government areas (LGAs) (Enugu State Agricultural Development Programme (ENADEP 2008) and a population of about 4,433,834 persons (Worldometer, 2020). The major agricultural practice in the State is crop farming. Though, animals are reared in all parts of the State although 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 (National Agricultural Extension Research Liaison Service & Project Coordinating Unit, 2006). According to ENADEP (2008) Enugu State is delineated into three (3) 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

Multi-stage sampling procedure was used in selecting 90 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 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 in a ratio proportional to the size of the population of rice farmers in each stratum, 59 for rice farmers without off-farm work and 31 for rice farmers with off-farm work. The sample frame was the list of rice farmers obtained from ENADEP.

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 were collected.

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.

Stochastic Frontier Production Function

Following the specification proposed by (Battese et al. 1997; Chang & Wen 2011) this study employed a stochastic frontier model that 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:

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

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 x 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^2_{u}i as specified below:

$u_i \sim N^+(\bar{u}_i, \sigma^2_u)$ (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 is the noise component that investigate risk effects which follows a normal distribution with zero mean and variance $\sigma^2_{v_i}$ as specified below:

$v_i \sim N(0, \sigma^2_{v_i});$ (3)

$\sigma^2_{v_i} = \exp(z_i\gamma).$

Where:

z_i = vector of the exogenous determinants which include z_1 = family labour used in rice production per ha (person-days); z_2= hired labour used in rice production per ha (person-days); z_3= depreciated value of farm implements used (naira)

γ= vector of unknown parameters (coefficients) associated with the production risk

The risk function is assumed to have an exponential functional form.

RESULTS AND DISCUSSION

Summary statistics of all the variables used in the analysis are presented in Table 1.

Table 1: Summary Statistics of Variables for the Analysis

Variable	Unit	Mean	Std. Dev.	Minimum	Maximum
Lnoutput(Y)	Kg	8.37	0.72	7.31	10.31
Lnseed	Kg	5.58	0.73	4.61	7.60
Lnfertilizer	Kg	5.68	1.80	4.61	7.72
Lnfarmsize	Ha	0.27	0.76	-1.14	2.30
Lnfamilylabour	Mandays	5.26	5.31	3.18	7.54
Lnhiredlabour	Mandays	5.76	2.85	4.63	8.40
Lnagrochemicals	Naira	9.73	0.69	8.31	11.50
Lnequipment	Naira	9.95	0.70	7.91	11.79
AvgNoAsso	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/yr	2.59	0.85	2	5

Source: Field Survey, 2012

Input-output elasticities of rice production

The estimation result of the stochastic production frontier model is presented in Table 2. The parameters of the stochastic production frontier model with a flexible risk specification were estimated simultaneously using the linear estimation procedure of the maximum likelihood estimation available in the statistical software STATA 11. The upper section of the Table 2 represents coefficients of the production function, while the middle and lower sections represent coefficients of the production risk and production inefficiency function respectively.

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.

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

Variables	**Without off-farm work**		**With off-farm work**	
	Coefficient	**Std. Err.**	**Coefficient**	**Std. Err.**
Production function				
Lnseed	0.017***	0.013	0.162***	0.000
Lnfertilizer	0.011***	0.000	0.014***	0.000
Lnfarmsize	-0.107***	0.012	0.033***	0.000
Lnfamilylabour	-0.027***	0.000	0.018***	0.000
Lnhiredlabour	0.002*	0.000	0.058***	0.000
Lnagrochemical	-0.113***	0.006	-0.043***	0.000
Lnequipment	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	-14.458***	3.041
Constant	-14.256***	5.830	-14.458***	3.041
Risk function				
Lnfamilylabour	1.287***	0.191	-1.198	0.999
Lnhiredlabour	-0.052	0.093	-0.087	1.000
Lnequipment	-12.255***	1.442	-0.005	1.000
Constant	107.161***	13.032	-29.649	0.995
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

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 1% 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 was found to be negative; it could be that the farmers are not applying it in the right quantity required.

This is followed by farm size (-0.107). This means that a 1% 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; 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 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 since this group engage in off-farm work they will need to engage the services of very competent hired labour to take care 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).

Factors that influence technical inefficiency of rice farmers

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.

As indicated in the middle section of Table 2 socio-economic characteristics such as average number of associations, age, education, household size and extension access had significant influence ($p<0.01$) on the technical inefficiency of the two groups of farmers and so the null hypothesis was rejected.

Factors that influence production risks of rice farmers.

This result is presented in the lower section of Table 2. For farmers without off-farm work, family labour has a positive and significant effect on production risk, meaning that family labour is a risk increasing factor. Depreciated value of equipment used has a negative and significant effect on production risk which indicates that investment on equipment will decrease the production risk in rice production. This agrees with the findings of Just and Pope (1979); Gardebroek, Chavez and Lansink (2010) and Chang and Wen (2011).

This means that a risk averse rice farmer in the study area is expected to use more of equipment and less of family labour.

For the group of rice farmers with off-farm work none of the factors were significant even though they all had negative signs.

CONCLUSION AND RECOMMENDATIONS

The study investigated the factors that influence the technical inefficiency and production risk among rice farmers in Enugu State, Nigeria. The results of our study suggest that to increase the output of rice farmers in the study area the use of equipment, seeds and fertilizers should be encouraged and promoted as it boost rice output. Also, the result shows that socio-economic factors such as household size decreases technical inefficiency while age and extension access had positive influence on technical inefficiency of rice farmers. This could imply that 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 or that the extension agents 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. Finally, it can be concluded from the results of the study that a risk averse rice farmer in the study area is expected to use more of equipment and less of family labour. The study is proffering the following recommendations:

i. Extension agents should educate the farmers on the proper application of agrochemicals and other basic farm management principles to enhance efficiency.

ii. Government should come up with programmes and policies that will encourage the younger generation to actively engage in rice production and there should be an evaluation of the extension services provided to the farmers to ensure it is relevant and up-to-date.

iii. The farmers should be encouraged to invest in equipment as this decreases production risk in rice production. Also, the government should support the farmers with equipment such as tractors to enhance their output.

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