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Determination of Technical Efficiency among Eggplant *(Solanum* sp.) Farmers Using The Stochastic Frontier Model in Isialangwa Area of Abia State, Nigeria

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Abstract: The study was conducted to determine the technical efficiency of eggplant producers using the stochastic production function. A cost route approach was adopted in eliciting information from 120 eggplant producers selected through multi-stage random sampling technique. The results show that the significant factors of technical efficiency are labour, fertilizer and seeds. The socio economic determinants of technical efficiency in the frontier model include gender, land tenure status, marital status and extension visits. The farmers were not fully technically efficient in the use of production resources. The mean technical efficiency is 0.78. Farmers can improved on their efficiency by forming cooperative societies to guarantee security of tenure and take advantage of cooperative farming.

Key words: Stochastic production frontier, technical efficiency, cost route, variance ratio, maximum likelihood

INTRODUCTION

Nigeria has been classified as a country where diet is dominated by starchy stable food comprising of cereals, roots and tubers, which provide calories needed for body energy but are very low in other nutrients[1]. The report further noted that little attention is paid on traditional vegetables which have very high nutritive value. One of such traditional vegetables is the eggplant. It is very much grown in Nigeria especially in the south-east agro-ecological zone as sole crops in smallholder farms.

Studies have shown that food crop farmers in developing ountries in general and Nigeria in particular have low productivity because of inefficiency in resource use[2-4]. The presence of inefficiency in production connotes the ability of increasing output without necessarily using additional inputs and new technology[5,6]. The problems of resources in relation to human wants, with the difficulty of tapping the resources or controlling them in production process are great obstacles to efficient resource utilization[7-9].

Resource use efficiency and productivity are influenced by a variety of factors which include, the type of technology, level of capital utilization, the commitment of the labour force and the level of skill acquisition, both managerial and technical. Thus, the study measured the level of technical inefficiency in eggplant production using the stochastic frontier model and the socio-economic factors that determine the efficiency of the farmers.

MATERIALS AND METHODS

The study area: The study was carried out in Isiala Ngwa North Local Government Area, in the Umuahia agricultural zone of Abia State in Nigeria. The area falls within the tropical rain forest zone having favourable climate and adequate moisture ideal for Eggplant cultivation. Isiala Ngwa North is made up of four clans, namely Nsulu, Ntigha, Ngwaukwu and Umuoha clan. These four clans are made up of forty-one autonomous communities.

Sampling procedure: Isiala Ngwa North was purposively selected for the study given the large number of Eggplant farmers. Thereafter, multi-stage random sampling was undertaken to select autonomous communities, villages and respondents. Ten autonomous communities were randomly chosen from the forty-one while two villages are chosen from the ten autonomous communities. Twenty villages were thus involved and six Eggplant farmers were randomly selected from each village, given a sample size of 120 farmers.

Data collection: A cost route approach was adopted in data collection. Data collection covered one production

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cycle from site preparation to harvesting. Data were collected in the 2004/2005 cropping season. Twenty trained enumerators, one assigned to each village assisted in data collection with the aid of a structured questionnaire. Data collected included plot sizes, capital inputs, quantities of seed, labour, fertilizers, outputs and prices.

Analytical techniques: In estimating the technical efficiency, the Cobb-Douglas functional form of the stochastic frontier model is estimated. The model is specified thus:

$$\text{In } Yi = \beta_0 + \beta_1 \text{In } X_1 + \beta_2 \text{In } X_2 + \beta_3 \text{In } X_3 + \beta_4 \text{In } X_4 + \beta_5 \text{In } X_5 + Vi - Ui \quad (1)$$

Where:

In = The natural logarithm
Yi = Output in Kg.
X_1 = Farm Size in hectares
X_2 = The labour input in Mandays
X_3 = Depreciation of Implements in Naira
X_4 = Fertilizer in kg
X_5 = The quantity of seeds in Mg
Vi = Error term not under the control of farmers
Ui = Error term under the control of farmers - Technical inefficiency
B_0 = Intercept
β_1 _ β_5 = Parameters to be estimated

The socio-economic determinants of the technical efficiency was simultaneously modelled and defined by:

$$E\{Exp(-Ui)\} = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 Z_5 + \beta_6 Z_6 + \beta_7 Z_7 + \beta_8 Z_8 + \beta_9 Z_9 + e_i \quad (2)$$

Where:

E{Exp(- Ui)} =Technical efficiency of the ith farm
Z_1 = Farmer's Education in years spent in school
Z_2 = Gender (Male = 1, Female = 0)
Z_3 = Farming experience in years
Z_4 = Land tenure status (Owner = 1, Rented = 0)
Z_5 = Marital Status (Married = 1, Otherwise = 0)
Z_6 = Number of Extension Visits
Z_7 = Number of farm locations
Z_8 = Credit use in Naira
Z_9 = Membership of Cooperative (Member = 1, Otherwise = 0)
e = Error term
$\alpha^{'s}$ = Coefficients
α_0 = Intercept

RESULTS AND DISCUSSION

The technical efficiency of Eggplant farmers was estimated using Cobb-Douglas functional form of stochastic frontier production. The result is presented in Table 1.

The result of the Stochastic frontier production function for Eggplant indicate that the production factors of labour, fertilizer and seeds were statistically significant. The coefficient of labour is positive and statistically significant at 5%. This is not surprising given the fact that all the agronomic practices involved in Eggplant production are done manually and thus labour intensive.

The implication here is that if labour use is increased by 10%, output will increase by 4.6%. The increase in output is less proportional compared to increase in labour. Fertilizer is however significant and positive at 10%. The vegetative nature of the crop is shown that output is heavily dependent on the extent of soil fertility. There is heavy application of fertilizer and organic manure in the area. The coefficient for seed is positive and statistically significant at 10% probability level. This implies that the more seeds used, the more the quantity of Eggplant obtained. The sign identity of the coefficients is consistent with *a-priori* expectation and consistent with findings of Ajibefun and Daramola[8].

The diagnostic statistics have coefficients that are all statistically significant at 1.0% risk level. The coefficient of total variance (δ^2) is 0.933 while the variance ratio is 0.651, which is the ratio of the variance of farm specific technical efficiency to the total variance. This would mean that 65.1% of the variation in output among the farmers is due to the disparities in technical efficiency.

The maximum likelihood estimates of the effects of some socio-economic factors on farmers technical efficiency is equally shown in Table 1. The result indicates that gender, marital status, land tenure status and extension visits were significant at 5% and the variable that explain farmer's technical efficiency. The coefficient of gender is negative and statistically significant at 5%. This implies that women were less technically efficient than men. The result is in conformity with that of Nwaru[10]. Tenurial status is positive and significant at 10%. This is very important because of security of tenure. Landowners are better-off adopting soil management practices that the benefits span over a long period of time. Tenants are not willing to adopt long-term soil improvement measures because of insecurity of tenure and tenures status that last a few years. Marital status is positive and significant at 10%. Married couples

Table 1: Maximum likelihood estimation of the Cobb-Douglas stochastic production function

Production factors	Parameter	Coefficient	Standard error	T-value
Constant term	β_0	3.568	0.383	9.307***
Farm size (X_1)	β_1	-0.066	0.165	-0.401
Labour (X_2)	B_2	0.459	0.174	2.632**
Depreciation (X_3)	B_3	-0.042	-7.245	0.573
Fertilizer (X_4)	B_4	0.142	-7.488	1.896*
Seeds (X_5)	B_5	0.199	-7.786	2.552**
Efficiency factors				
Education (Z_1)	α_1	-1.432	-1.394	1.027
Gender (Z_2)	α_2	-0.098	-0.045	2.193**
Farming experience (Z_3)	α_3	-0.433	0.273	0.574
Land tenure status (Z_4)	α_4	0.142	-0.075	1.896*
Marital status (Z_5)	α_5	2.987	1.715	1.742*
Extension visits (Z_6)	α_6	-0.110	-0.058	-1.886*
Farm location (Z_7)	α_7	-0.622	0.641	-0.971
Access to credit (Z_8)	α_8	-0.106	0.798	-1.386
Membership of cooperative society (Z_9)	α_9	0.602	0.502	1.120
Diagnostic statisticstotal variance	δ^2	0.933	0.230	4.057***
Variance ratio	γ	0.651	0.122	5.326***
LR test				
Log likelihood function i 116.883				

Note: *** Significant at 1%, ** Significant at 5%, * Significant at 1%, Source: Complied from Field Survey Data 2005 using Frontier 4.1 by Coelli[11]

Table 2: Frequency distribution of technical efficiency indices

Technical efficiency index	Frequency	Percentage (%)
0.00-0.40	1	0.33
0.41-0.60	5	4.16
0.61-0.80	51	42.50
0.81-1.00	63	52.50
Total	120	
Maximum technical efficiency	0.975	
Minimum technical efficiency	0.105	
Mean technical efficiency	0.780	

Source: Computed from Field Survey, 2005

provide better combination of resources especially labour since most of the operations are tedious and labour intensive. The coefficient of extension visit was significant but do not conform to *a-priori* expectation. The coefficient is negative and varies from that obtained by Amaza and Olayemi[12] who had reported a significant and positive relationship between extension contact and technical efficiency. The negative coefficient may be explained by the complain of the farmers of the high cost of adoption of the improved technology.

The frequency distribution of efficiency estimates obtained from the Stochastic frontier model are presented in Table 2.

The result in Table 2 shows that less than 5% of the farmers operated below efficiency level of 60%. The greater majority of Eggplant farmers were highly technically efficient as about 95% attained efficiency greater than 60%. The mean technical efficiency for the sample is 78% with a minimum of 10.5%. This implies that on the average farmers are able to obtain 78% of potential output from a given mix of production inputs. In the short-run, there is scope for increasing Eggplant output by 22% by adopting the techniques and technology employed by the best Eggplant farmers. The implication of the result is such that the average Eggplant farmer requires 20% i.e., {(1 - 0.78/0.975)} 100 cost saving to attain the status of the most efficient Eggplant farmer while the least performing farmer would need 89.2% i.e., {(1 - 0.105/0.975)} 100 cost saving to become the most efficient Eggplant farmer.

CONCLUSION

The study has revealed that Eggplant farmers are not fully technically efficient, although the mean technical efficiency of the farmers are relatively high (79%). The socioeconomic determinants of technical efficiency include marital status, extension visits and tenurial status. To further improve technical efficiency Eggplant should form cooperative societies to enable them get long-term security of tenure. This will equally guarantee the adoption of long-term soil improvement measures to increase productivity and accessibility to high yielding seeds.

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