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Technical Efficiency Analysis of Improved Cassava Farmers in Abakaliki Local Government Area of Ebonyi State: A Stochastic Frontier Approach

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Abstract: A Cobb-Douglas stochastic frontier production function was employed to measure the level of technical efficiency and its determinants in improved cassava production. The study was carried out in Abakaliki Local Government Area of Ebonyi State, Nigeria. A structured questionnaire was used to obtain data from 120 contact farmers sampled through a multistage random sampling procedure. Result showed that the mean technical efficiency of the respondents was 92%, implying that efficiency level could be increased by 8% through better use of available resources. Hence, the farmers did not achieve maximum technical efficiency. Analysis indicated that the coefficients of fertilizer and tractor use were positive and significantly related to cassava output at 5% level. The farmer's level of technical efficiency was significantly affected by level of education and farm size. While the educational level had positive effect, farm size had negative effect on technical efficiency level of the farmer.

Key words: Technical efficiency · Improved technologies · Cassava farmers · Stochastic frontier · Cobb-Douglas production function · Ebonyi State

INTRODUCTION

Cassava (*Manihot esculenta Crantz)* is a root and tuber crop grown in all ecological zones of the country, but most predominantly in the Southern parts and middle belt of Nigeria. It is generally accepted and recognized as a good source of vital nutrients and energy for the body. Hence, it has over time, evolved as the most staple and choice food for most people in the country. Cassava is rich in carbohydrates, starch, protein, fats, ash, fibre among others, which makes it a very good and reliable source of food, energy, sweeteners and industrial raw materials. Cassava also serves as the last resort or reserve in times of famine or food scarcity, due to its capacity to grow and be available all year round, notwithstanding soil or climatic conditions.

These outstanding features of cassava have prompted the federal government to initiate and execute policies and programmes aimed at increasing production through the efficient utilization of improved production technologies. The aim of these programmes and increment in cassava inputs is to tap the potentials of the cassava crop, which has remained largely unappreciated and unharnessed. Asogwa *et al.* [1] also noted that the input expansion policy of government in the cassava industry through the provision of improved cassava varieties and improved processing technology will lead to efficient use of resources in cassava production in Nigeria. Hence, the only way to increase the production of cassava is through the adoption and efficient utilization of improved technologies by farmers, which could lead to increased productivity and income [2].

Studies [3-5] have shown that farm efficiency is an important subject in developing countries agriculture and several methods have been developed to measure it. Early studies focused primarily on efficiency using deterministic production function with parameters computed using mathematical programming techniques [3]. They however noted that the approach has inherent limitations of the statistical inference on the parameters and resulting efficiency estimates, due to the inadequate characteristics of the assumed error term. The stochastic frontier analysis developed independently by Aigner *et al.* [6] and Meeusen and van den Broeck [7],

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which overcome this deficiency have been used in determining farm level efficiency using cross-sectional data [4]. He further noted that the empirical studies that have made use of this model in determining efficiency in crop production in Nigeria is increasing. However, there are relatively few studies on cassava production using improved technologies in Abakaliki local government area of Ebonyi State.

The objective of this study is therefore to use the stochastic frontier analysis to measure farmer's level of technical efficiency and its determinants in cassava production using improved technologies.

MATERIALS AND METHODS

Study Area: The study was conducted in Abakaliki Local Government Area (L.G.A), which is one of the thirteen L.G.As in Ebonyi State. The L.G.A is made up of eight communities namely: Amachi, Amagu, Edda, Izzi-Unuhu, Ndebor Okpuitumo, Enyigba and Abakaliki Urban. NPC [8] Figure shows that the population of the area is 151,723. The soil type is predominantly sandy loan with some swamp areas especially along the river banks. These support the growing of such staple food crops as rice, cassava, yam, maize, potatoes and vegetables, with mixed cropping predominantly practiced.

Sampling Technique: The population of the Ebonyi State Agricultural Development Programme (EBADEP) contact farmers in each of the eight (8) communities in the study area is about 50 farmers. A multistage random sampling technique was used. First, five (5) communities were randomly selected and the contact farmers in the selected communities identified. Second, twenty-four (24) contact farmers were randomly selected from each of the 5 communities already selected. This gave a total of 120 contact farmers used for the study. Data collection was by the use of structured questionnaire.

Analytical Technique: Data analysis was done by the use of descriptive and inferential statistics. Means, percentages and frequency Tables were used in analyzing the distribution of technical efficiency levels. A Cobb-Douglas stochastic frontier production function was estimated using the maximum likelihood estimation (MLE) technique to obtain farm specific technical efficiencies and their determinants.

Model Specification: The stochastic frontier production function is defined by

$$Yi = f(Xi, \alpha) + \varepsilon \quad (1)$$

Where:

Yi = Output of ith cassava farmer using improved technologies
Xi = Vector of improved inputs used by ith farmer
α = Vector of unknown parameters
ε = Vi-Ui is the composed error term [6].

The two components Vi and Ui are assumed to be independent of each other; where Vi is two sided, normally distributed random error ($Vi \sim N(0,\sigma^2 v)$ and Ui are one sided, non-negative variables with a half-normal distribution ($Ui \sim N(0, \sigma^2 u)$, which are assumed to account for technical inefficiency in production [9-12].

A Cobb-Douglas function was fitted to the stochastic frontier production function using the maximum likelihood estimation. The function is explicitly expressed as:

$$Ln\ Yi = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \varepsilon \quad (2)$$

Where:

Yi = Output of harvested cassava in Kg
X_1 = Fertilizer applied in Kg
X_2 = Expenses on improved planting materials (valued in Naira)
X_3 = Expenses on tractor used (valued in Naira)
X_4 = Expenses on agro-chemicals (valued in Naira)
Ln = Natural logarithm
ε = Composite error term defined as Vi-Ui in Equation (i)

The maximum likelihood estimation estimates of the parameters of the model and the predicted technical efficiency for each farmer were obtained by using the computer programme Frontier Version 4.1c. The determinants of technical efficiency were modeled in terms of farm/farmer characteristics and were specified thus:

$$T.Ei = \exp(-Ui) = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + ei \quad (3)$$

Where:

$T.E_i$ = Technical efficiency of the ith farmer
X_1 = Gender (Dummy: male = 1, female = 0)
X_2 = Farmer's age in years
X_3 = Farmer's household size
X_4 = Educational background in years
X_5 = Years of farming experience
X_6 = Farmer's income (in naira)
X_7 = Farm size in hectares
a_0-a_7 = Regression parameters to be estimated
ei = Error term

RESULTS AND DISCUSSION

Table 1 shows that the technical efficiency levels of cassava farmers in the study area who used improved technologies ranged from 0.68 - 0.98. The mean technical efficiency estimate was 0.92. While 90% of the farmers attained between 0.90 and 1.00 efficiency levels, none of the respondents attained less than 0.50 efficiency levels. Only 9% of the cassava farmers attained a technical efficiency level of between 0.70 and 0.89. Generally, there was a high level of technical efficiency among the farmers, which according to Idiong [13] indicates that only a small fraction of the output can be attributed to wastage. The result also shows that many of the respondents produced close to their production frontier where profit is maximized. However, there are about 9% allowances for the cassava farmers to improve their efficiency levels. Furthermore, the result indicates that for an average cassava farmer to attain the level of most technically efficient respondent, the farmer would realize about 6% in cost savings.

The maximum likelihood estimates of the stochastic production frontier function for cassava farmers in the study area who used the improved technologies are presented in Table 2. The results show that the coefficients of the variables have the expected positive sign. However, only the coefficients of fertilizer and tractor use were significant at 5% level. This indicates that an increase in fertilizer usage, increases significantly cassava output. This result highlights the importance of fertilizer in increasing crop yield as low fertilizer usage tends to decrease agricultural growth. Similarly, an increase in the use of tractor in cassava production tends to significantly increase the output produced. This could be as a result of more acreage put under cultivation.

The gamma value (= 0.5847) which is significant at 1% level shows that about 58% variation in the output of cassava is attributed to technical inefficiency. Though low, the significant value of the sigma-squared (0.0194) indicates the correctness of the specified assumption of the composite error term.

In Table 3, the determinants of technical efficiency of cassava farmers who used improved technologies were presented. The coefficients of educational background and farm size of the farmers were significant. While the coefficient of educational background was positively signed, the coefficient of farm size was negative. This result indicates that the efficiency of cassava farmers who use improved technologies increases with increase in their years of schooling. Education enhances the acquisition and utilization of information on improved technology by farmers [13, 14] and this significantly increases efficiency [15]. Result on farm size shows that smallholder cassava farmers could be more efficient in resource allocation than large farmers. Resources allocation and management in small farms are less complex than in large farms and do not require advance farm management knowledge, which could be lacking among smallholder farmers. Furthermore, the significant influence of farm size relates to capturing variation in efficiency that arises from differences in scale [10, 16].

Table 1: Distribution of respondents according to their technical efficiency levels

Technical efficiency level	Frequency	Percentage
0.50-0.69	1	0.83
0.70-0.89	11	9.17
0.90-1.00	108	90.00
Total	120	100.00

Source: Derived from output of Computer Programme Frontier 4.1c

Table 2: Maximum likelihood estimates of the stochastic production frontier function in cassava production using improved technologies

Variable	Coefficient	T-ratio
Constant	4.090	151.7750
Fertilizer (X_1)	0.00000212*	4.0340
Improved planting material (X_2)	0.000000944	0.0713
Tractor use (X_3)	0.154*	10.3990
Agrochemicals (X_4)	0.000000785	0.0950
Diagnostic statistics		
Gamma	0.5847*	4.132
Sigma-squared	0.0194*	4.779
Log-likelihood function	95.014	
LR test of one-sided error	3.762	

Source: Output of Computer Program Frontier 4.1c
*Significant at 5% level

Table 3: Determinants of technical efficiency of cassava farmers using improved technologies

Variable	Coefficient	T-ratio
Constant	0.914*	42.129
Gender (X_1)	0.027	0.309
Age (X_2)	- 0.034	0.236
Household size (X_3)	0.041	0.371
Educational background (X_4)	0.586*	4.913
Farming experience (X_5)	0.084	0.587
Farm income (X_6)	- 0.071	0.558
Farm size (X_7)	- 0.301*	2.335

Source: Computed from Frontier Version 4.1c
*Significant at 5% level

CONCLUSION

This study estimated the technical efficiency of cassava farmers who used improved technologies in cassava production. Results show that though majority of the farmers had high levels of technical efficiency, they did not produce at the frontier level. Hence, there is still allowance for efficiency improvement. The educational background of the farmers had a significant positive influence on technical efficiency. Therefore, the farmers should be encouraged to take advantage of various educational programmes such as the Work and Study Programme (WASP) of the Ebonyi State University, Abakaliki to improve their levels of education. This will also help to improve their managerial ability to handle larger farms.

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