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Technical Efficiency of Cocoyam Farmers in Adavi and Okehi Areas of Kogi Sate, Nigeria: A Stochastic Frontier Approach

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ABSTRACT

Cocoyam in spite of its nutritional value and being one of the staple food crops in Kogi state has not been fully exploited in terms of research. This study therefore analyses the level of technical efficiency and its determinants among cocoyam farmers using stochastic production frontier approach. Primary data were collected from 190 randomly selected farmers in Adavi and Okehi Local Government Areas of Kogi State, Nigeria. Data collected on socioeconomic variables and input-output variables were analysed using descriptive statistics and stochastic frontier production function. The result shows that 73% of the cocoyam farmers were above 40 years of age, majority were male (72%) and had an average of about 28 years of experience in farming. Technical efficiency level among farmers ranges from 13% to 92% with mean technical efficiency of 64%. Level of education, household size, years of farming experience and mode of land acquisition were significant factors (p< 0.01) that increases level of technical efficiency and account for most of the variations observed in efficiency among the farmers. The study recommended that, there is need for improvement in the level of education and mode of land acquisition in order to further improve on the level of efficiency in production.

Key words: Cocoyam, farmers, stochastic frontier, technical efficiency, Kogi State

INTRODUCTION

Agriculture plays important roles in the development of any nation. It is from agriculture that man feeds his family with different food types such as yam, cocoyam, cassava, maize, milk and egg. In Nigeria, farmers have different reasons for cultivating major crops; some of the reasons include: provision for family's needs as well as commercial purpose. Cocoyam is an important staple food across many developing countries in Africa, Asia and the Pacific (Onyeka, 2014). It is particularly important in Sub-Saharan Africa where the two most commonly cultivated species (*Colocasia esculenta* and *Xanthosoma sagittifolium*) are grown extensively. The cultivation of cocoyam in most African countries is essentially by small-scale resource-poor farmers with minimal input. Cocoyam is the third important staple root/tuber crop after yam and cassava in Nigeria and play very important roles in the livelihood of rural farmers, who often resort to cocoyam a cheaper yam substitute, and alternative source of their daily calories especially during periods of food scarcity and economic stress (Onyeka, 2014).

Nutritionally, cocoyam is rich in carbohydrates with nutritional value comparable to potato and superior to cassava and yam in the possession of higher protein, mineral and vitamin contents as well as easily digestible starch (Parkinson, 1984). Cocoyam also contains higher appreciable amounts of essential minerals (Ca, Mg and P) than cassava and yam. It is highly recommended for diabetic patients, the aged, children with allergies and for other persons with intestinal disorders (Plucknett, 1970). The corms and cormels of cocoyam are processed by boiling, baking or frying in oil. They are also processed into different products in many parts of Africa. All major parts of cocoyam (corm, cormel and leaves) are edible. The young leaves are a nutritious spinach-like vegetable, which provides a lot of minerals, vitamins and thiamine. The yields are stable under condition where other crops may not succeed. The crop is popular in the middle belt area of the country e.g. Kogi, Benue, Kaduna and also western region comprising of Ekiti, Ondo, Osun state where it is highly cultivated as food and source of income for farmers (Olojede *et al.,* 2005).

In Kogi state, cocoyam is traditionally consumed when boiled and pounded like pounded yam with soup mixed with vegetables and either pork meat, Chicken, fishes or beef meat. It can also be peeled and boiled eaten with vegetable oil, palm oil, butter, milk, spices and salt

(Olojede *et al.,* 2005). It has a multiplicity of end uses, for example, it can be used for making starch, flour, soup, confectioneries in addition to its being consumed in various other forms in which other starchy staples can also be consumed. It is available all year round. It is also resistant to drought, pest and diseases and tolerant to a variety of climatic and soil conditions (Ogunniyi, 2008).
In spite of all of these advantages and uses of cocoyam, relatively little research attention has been devoted to cocoyam when compared to other root and tuber crops such as potatoes, cassava and yam. Consequently, cocoyam remains an under-exploited and poorly understood crop despite its nutritional value and its potential as a food and cash crop. Although the crop is contributing substantially to the food and income security of many households in West and Central Africa, well documented and consolidated information on technical efficiency of its production is scarce.

Furthermore, efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of farmers are resource-poor (Amos, 2007; Binam *et al.,* 2008; Nkamleu *et al.,* 2010). Technical efficiency here refers to the ability to produce the highest level of output with a given amount of resources. Based on the foregoing, it is therefore necessary to conduct this research to determine the level of technical efficiency and identify the determinants of technical efficiency among the cocoyam farming households.

MATERIALS AND METHODS

The Study Area

The study was conducted in Kogi state specifically in Adavi and Okehi Local Government Areas. The state is Located between latitudes 6.33^0 N and 8.44^0N and longitudes 5.40^0E and 7.49^0E. The region fall within the southern guinea savanna ecological Zone of Nigeria. There are two (2) types of season in the area. The raining season starts from April and ends October while the dry season starts from November and ends March. The temperature ranges between 27^0C and 37^0C. Majority of the people are farmers who cultivate various crops such as cocoyam, cassava, vegetable crops and rear livestock like poultry, cattle, goat and sheep as means of livelihood (Kogi State Government, 2015).

Data Collection

The data used for this study were primary data collected in 2013 through administration of a well- structured questionnaire. Two- stage random sampling technique was used to select the farmers. In the first stage twenty villages were selected from two Local Government Areas and in the second stage ten farming households were selected from each village to give a sample size of 200 farming households. However, 190 out of the 200 questionnaires were found useful for data analysis.

Analytical Techniques

The tools of analysis used in this study are the descriptive statistics and stochastic frontier model by Battese and Coelli (1995). The stochastic frontier production function model is specified in the implicit form as follows:

$$Yi = f(Xi, \beta) + (Vi - Ui)$$

Where:

Y_i is the output of the $_i{}^{th}$ farm in Kg

X_i is a k by l vector of input quantities of the $_i{}^{th}$ farm

β is a vector of unknown parameters to be estimated

V_i are random variables which are assumed to be normally distributed $N(0,\delta_v{}^2)$ and independent of the U_i. It is assumed to account for measurement error and other factors not under the control of the farmer.

U_i are non-negative random variables, called technical inefficiency effects (Aigner *et al*., 1977).

A Cobb-Douglas Production form of the frontier was employed and presented as follows:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + V_i - U_i \ldots\ldots\ldots(1)$$

Where,

ln = represents the natural logarithm the subscript i represent ith.

Y_i = Cocoyam output in kg of the ith farmers

X_1 = Size of land in hectare

X_2= quantity of planting material in kg

X_3 = quantity of fertilizer in kg

X_4 = Labour used in the farms (man-day)

β_0 =Intercept

β_1 - β_5 = Coefficient to be estimated

V_i = the systematic component, which captures the random variation in output, which are due to the factors that are not within the influence of the farmers (e.g. temperature, moisture, natural hazards).

The V is assumed to be independently, identically distributed with zero mean and constant variance
U_i = inefficiency component of the error term

A two-stage estimation procedure was followed in this study using the software program, FRONTIER VERSION 4.1 (Battese and Coelli, 1995). After the Cobb-Douglas production function was estimated, the inefficiency model was also estimated in the second stage by using the residuals in the first model and socio-economic variables. This model specifies technical inefficiency effects in the stochastic frontier model that are assumed to be independently (but not identically) distributed non-negative random variables as truncations at zero of the normal distribution (Coelli *et al.,* 1998). Specifically, the inefficiency effect is given as;

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$

Where, δ= Intercept

δ_0, $\delta_1 - \delta_7$ = parameters to be estimated

Z_1 = household size (number)

Z_2= Ages of the farmers (years)

Z_3= years of experience (number)

Z_4 = Educational status (Number of years spent in school)

Z_5= mode of land acquisition (owned = 1, otherwise = 0)

Z_6= extension visit to the farm (Number of visits)

Z_7= Membership of Association (yes =1or No = 0)

These socioeconomic variables were included in the equation because they were assumed to have impact on the efficiency with which farmers produce cocoyam. Many past studies on technical efficiency in agricultural production such as Chirwa (2007), Adewumi and Adebayo (2008), Donkor *et al.* (2008), Ogundari (2008), and Aneani *et al.* (2011) have tested the effects of these variables on technical inefficiency. Considering them in this study was not only appropriate from theoretical point of view but also for the purpose of comparison with findings of previous studies.

RESULTS AND DISCUSSION

The socio-economic characteristics of the cocoyam farmers

The frequency distribution of socio-economic characteristics of the farmers who engaged in cocoyam production in the study area is presented in Table 1. About 72 percent of the farmers are male. This shows that both men and women are involved in cocoyam farming but men generally are regarded as farm owners and head of households. This has implication on performing tedious work on the farm. Majority (about 69%) of the farming households are married. This may aid availability of family labour. The result presented on table 1 also shows that majority (72.63%) of the farming household heads are above 40 years of age with modal (61.05%) age group of 41-60years.

Table 1: Distribution of cocoyam farmers according to socio-economic characteristics

Variables	Frequency	Percentage (%)	Mean
Age of the farmers			
21 – 40 years	52	27.37	
41 – 60 years	116	61.05	43.97
>60 years	22	11.58	
Gender			
Male	137	72.1	
Female	53	27.89	
Households Size			
5and below	52	27.37	
6 – 10	124	65.26	
15-Nov	4	2.11	
16-20	6	3.16	
>20	4	2.11	7.47
Marital Status			
Single	42	22.11	
Married	132	69.47	
Divorced	6	3.15	
Widow	4	2.11	
Widower	4	2.11	
Separated	2	1.05	
Educational Status			
Primary	44	23.16	
Secondary	34	17.89	
Post-secondary	20	10.52	
No formal education	92	48.42	
Farming Experience			
Less than 10 years	20	10.53	
10 - 20 years	70	36.84	
21 – 30 years	30	15.79	27.67
31 – 40 years	26	13.68	
>40 years	44	23.16	
Total	**190**	**100**	

This result may imply decline in labour productivity as the farmers are tending towards old age. Ayanlere (2016) also found 59.66% of farming households in Kogi State within the same age group. Higher proportion (52.63%) of the respondents had over 20 years of farming experience. The minimum and maximum number of years of experience was 5 and 70 years respectively. This indicates that the farmers are highly experienced in the cultivation of cocoyam. About 52% of the farmers had one form of education or the other. This probably may increase level of innovation and adoption of technology by the farmers. Household size is an important source of family labour. About 65% of the cocoyam farming households has 6 to 10 members with mean size of seven persons. This may likely reduce cost of hired labour.

Level of the Technical Efficiency of cocoyam farmers in the study area

The summary of the technical efficiency level of the cocoyam farmers in the study area is as presented in table 2. The results showed that technical efficiency of cocoyam farmers varied widely between 0.13 to 0.92 with an average of 0.64. About 54% of the farmers were above this average while 46% were below. This result implies that if the level of efficiency of the farmers is increased by 36%, the farmers will be operating on the production frontier.

Table 2: Summary statistics of efficiency level among cocoyam farmers in the study area

Level of efficiency	Freq.	Percent (%)	Min	Max Mean
< 0.20	20	10.53	0.13	0.19 0.16
0.20 – 0.40	23	12.11	0.21	0.35 0.30
0.41 – 0.60	22	11.58	0.44	0.60 0.51
0.61 – 0.80	68	35.78	0.61	0.78 0.71
0.81 – 1.00	57	30	0.83	0.92 0.91
Total	190	100		
Mean Efficiency	0.64			

The maximum likelihood estimate (MLE) of the production function parameters for cocoyam production in the study area is presented in table 3. The coefficients of the estimated parameters have the desired positive signs. The coefficient of the estimated parameters for land (x_1) seed (x_2) and labour (X_4) are positive and statistically significant while that of fertilizer (x_3) is not. This implies that the more the area of land cultivated, quantity of planting materials and labour used as inputs the more the output of cocoyam. Fertilizer was not significant probably because the households' heads do not apply fertilizer adequately. This result may be interpreted to mean that the most important factors in the production of cocoyam in the study area are land, seed, and labour.

The variance parameter (δ^2) is positive and significant at 1% indicating goodness of the specified distributional assumptions of the composite error. The Lambda (λ) value of 4.06, which is greater than unity, signifies a good fit for the estimated model and also the appropriateness of the theoretically required distributional assumptions for the decomposed error terms (Tedesse and Krishnamoorthy, 1997). The gamma (γ) value of 0.98 represents the variation in the farmers output made on the production frontier which can be attributed to technical efficiency. This value which is close to one confirms that the technical inefficiency effects are significant in the estimated model.

The co-efficient of household size, years of farming experience and mode of land acquisition were positive and significant at 5 percent level of probability indicating a direct relationship with technical efficiency. This result agrees with the *a priori* expectation that household size, years of farming experience and land acquisition method increases technical efficiency. Onyenweaku and Nwaru (2005) also ascertained that these variables increase technical efficiency. The coefficient for education was also positive and significant at 1 percent level of probability. This result also agrees with *a priori* expectation that education increases productivity and enhances farmers' ability to understand and evaluate new production techniques. This result is consistent with the findings of Oyeuweaku and Nwaru (2005) and Onu*etal.* (2000). However, coefficient of extension visits and membership of association were negative and not significant at 1 and 5 percent respectively.

Table 3: Maximum Likelihood Estimates of Cobb Douglas Stochastic Frontier Production Functions for Technical Efficiency of Cocoyam Production in the Study Area

Variables	Parameters	Co-efficient	Standard error	T- Ratio
Constant	X_0	5.62	0.99	5.67***
Land	X_1	0.45	0.16	2.81 **
Seed	X_2	0.06	0.02	3.28 ***
fertilizer	X_3	0.18	6.99	0.03
Labour	X_4	0.13	0.04	3.25 ***
Efficiency Factor				
Constant term	Z_0	0.56	0.09	6.15***
Household size	Z_1	1.39	0.65	2.14**
Age of the farmers	Z_2	-1.21	1.26	0.96
Years of farming experience	Z_3	0.1	0.05	2.17 **
Educational status				
Mode of land acquisition	Z_4	1.16	0.34	3.40 ***
Extension contacts	Z_5	0.68	0.32	2.12**
Membership of association	Z_6	0.32	0.39	0.83
Variance parameters				
Sigma-squared (δ^2)	Z_7	-0.16	1.04	-0.15
Gamma (γ)				
Lambda (λ)		0.4	0.05	7.98***
		0.98	0.65	1.92
		4.06 ***		

CONCLUSION

From the findings of this study, it can be concluded that household size, years of farming experience, education and mode of land acquisition are important factors determining technical efficiency in the study area. The level of technical efficiency observed among the farmers also is a clear indication that there are opportunities to increase productivity of the farmers in the study area through more efficient use of production resources available for farming operations.

RECOMMENDATION

Based on the findings of this study, it is therefore recommended that:

1. Ownership of land should be encouraged among the farmers through community efforts. Since mode of land acquisition is a significant factor in the study, ownership of land could make farmers enjoy security of tenure which may have positive implications on efficiency.
2. Level of education of farmers in the area is average but could be improved upon as it is also a significant factor in determining technical efficiency in the area

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