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TECHNICAL EFFICIENCY OF SMALL-HOLDER CASSAVA-BASED FARMERS IN ABIA STATE, NIGERIA

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Abstract
The global issue that is central to attaining food security is the problem of efficiency in agricultural production. This affects the farmers' ability to optimize their farm production objectives through efficient management of productive resources. As a result, improving the efficiency of farmers will create a balance in the prevalent food supply and demand deficit, with opportunities to leverage on the surpluses for investment into more expansive production. The specific objectives of the study were to: describe the socio-economic characteristics of cassava-based farmers; estimate the profitability of small-holder cassava farmers; determine the technical efficiency of small-holder cassava farmers and estimate the elasticity of production as well as returns to scale of cassava production in the study area. Multi-stage sampling procedure was employed in the random selection of 120 small-holder cassava farmers that were used for the study. Data were collected through the use of questionnaire and interview schedule. The data collected were analyzed using Descriptive Statistics, Farm Budgetary Technique and Inferential Statistics – Stochastic Frontier Production Function. Findings from the socio-economic characteristics reveal that most of the cassava-based farmers are between the age of 40 to 49 years and that 67.5% of the farmers are married with the mean household size of 6 persons per head. The results of costs and return show an estimated Net Income of N11,908.29 per hectare, while the Return on Investment estimated is 0.04. Findings from the Stochastic Frontier Function reveal that the δ^2(0.23) and γ(0.8) are statistically significant at 5% and 1% levels respectively. The coefficient of the variance ratio (γ) implies that 80% variation in output was as a result of inefficiency differences among small-holders cassava farmers. Also, cassava stem(0.3738), farm size(0.3412) and fertilizer(0.0710) are the significant production inputs that influenced cassava output while household size(-0.1563) and marital status(0.4706) are significantly related to technical inefficiency. The results also reveal a Mean Technical Efficiency of 0.81. Nevertheless, cassava output is proportionately less than the bundles of inputs utilized, thus indicating decreasing returns to scale. However, the study concluded that the cassava-based farmers managed to recover their expenses in production and there exist little room for improvement in technical efficiency. Relevant stakeholders in agriculture should sensitize the cassava producers on appropriate application of production inputs in order to minimize wastages.

Key Words: *Cassava, Profitability, Small-holder Farmers, Technical Efficiency*

Introduction

Cassava (*Manihot esculanta*) is a starchy root crop which belongs to the family of *Euphorbiaceae*. It is believed to have originated from South-America and was introduced in the Republic of Congo and subsequently to West Africa by the Portuguese traders about 400 years ago (Nweke, 2004). Cassava is one of the most important root crops in Nigeria and serves as a major economic food security crop, thus meeting the food needs of the populace (Okoh, 2016). It is the most widely grown crop in the country in terms of the area of land devoted to it - claiming 60% of the total area under cultivation in the Southern part, while in the Northern part of the country, it covers 40% of the total area under cultivation (Okoro &Ujah, 2009). Its growing importance has also been witnessed in the South-eastern part of Nigeria.

Cassava achieved an export status because of the increasing demand for its industrial raw material and use for animal feeds. The study by Central Bank of Nigeria (2010) revealed that Nigeria needs to produce about 150 million metric tonnes of cassava per annum in order to meet the export and domestic demand. These however prompted the Federal Government to fashion out a policy on cassava production with a view to develop strategies that will stimulate domestic production. As part of the measures to encourage more production and utilization, Nigeria adopted a policy compelling flour mills to implement the 10 percent cassava flour component in wheat flour for use in bakery and confectionery products. This policy, backed by improved varieties from International Institute of Tropical Agriculture, Ibadan and National Root Crop Research Institute Umudike raised cassava production by 10 million tonnes (International Institute of Tropical Agriculture, 2017).

Nigeria is experiencing productivity shortfalls in cassava production despite her being the leading producers of cassava in the world, producing over 21% of the world's total output (Olaniyan, 2015). Given the actual yield of cassava ranging between 7 to 15 tonnes per hectare as compared to a potential yield of 30 tonnes per hectare – a yield difference of 275 and 100 percent respectively (FAO, 2011; as cited in International Institute of Tropical Agriculture, 2015), the current prospects in cassava enterprise and its capacity to boost the income generation of cassava value chain actors in addition to raising the foreign exchange earning of the economy has been under-exploited. This occurs because cassava producers find it difficult to procure production inputs such as capital, improved cultivars, agrochemicals and other new technologies as most of these inputs are very expensive or have not been widely adopted (Anyanwu, Kalio & Olatunji, 2014), thus, implicating under-exploitation and low productivity in the cassava industry. Similarly, the study by Achoja, Edoga, Ukwuaba, and Esowhode (2012) found that most of the cassava farmers are working poor because of their poor financial base, hence, making it difficult for cassava enterprise owners to acquire those equipment and tools they do not have to facilitate expansive production. The situation becomes worse on the account of continuous exploitation by middlemen who cause the farmers to receive lower prices for their produce as well as labour intensiveness of cassava production which mount heavy decline on the profit of the farmers. Also, the problem of obtaining outputs below the production cost may not only bring about reduction in the profit of the farmer, but affect the living conditions due to insufficient surplus produce which is often sold to meet other household commitments. All these are the major factors that discourage the farmers and affect their level of income despite all efforts. It also contributes to the shortage in food supply in Nigeria. However, the economic and nutritional importance of cassava can play a major role in tackling Nigeria's food crises brought about by poverty and population boom. This implies that empirical evaluation of the technical efficiency levels are essential in order to determine the magnitude of the gains that could be obtained by increasing cassava production with a given technology, thereby guaranteeing higher income for the cassava farmers.

However, most of the studies that investigated into cassava production and efficiency in the study area (Iheke & Nwaru, 2009; Asogwa, Ihemeje & Ezeihe, 2011; Igwe, Mbanasor, Okoye & Imuse, 2012 & Oteh, 2017) used either the restricted Cobb-Douglas specification or the Maximum Likelihood Estimation production technology, thereby providing no alternative to choose the best specification between the models It is on this foreground that this study assessed the technical efficiency of small-holder cassava farmers on the two functional forms in order to determine the best model that represent the state of the underlying technological relationship. Also, it is important to note that cassava is widely produced in the study area (Oteh, 2018), hence justifies the purpose of this research as its importance to the people cannot be over emphasized. Accordingly, the study specifically sought to: describe the socio-economic characteristics of the cassava-based farmers; estimate the profitability of cassava production in the study area; determine the technical efficiency of cassava producers in the study area; estimate the elasticity of production and returns to scale of cassava production in the study area.

Materials and Methods

The study was conducted in Abia State. The State lies within Latitudes 5° 31' 29.68°N of the Equator, and Longitudes 7° 29' 40.60°E of the Greenwich Meridian. It is bounded by Rivers State to the South, Ebonyi State, Anambra and Enugu State to the North, Imo State to the West and Akwa Ibom State and Cross-River State to the East. The State is administratively divided into 17 Local Government Areas. It has a projected population density of 3,727,300 persons with an estimated annual population growth rate of 2%, covering a total land area of 4900 square kilometres (National Bureau of Statistics, 2016).The climate is tropical and humid all year round. Abia state is richly endowed with natural and human resources. Most of the land is arable and with its adequate seasonal rainfall, the farmers produce: cassava, yam, garden egg, maize, cucumber, rice, plantain, cashew, cocoa, palm oil and cocoyam. The State is divided into three agricultural zones namely: Aba, Umuahia and Ohafia agricultural zones.

Multi-stage random sampling procedure was used in this study. In stage one, two agricultural zones were randomly selected from the three agricultural zones in the study area. In stage two, three Local Government Areas were randomly selected from each of the two agricultural zones making six Local Government Areas. Stage three involved random selections of two communities from each of the six Local Government Areas thus selected. This gave rise to 12 communities that were used for the study. Finally, in stage four, 10 cassava farmers were randomly selected in each of the 12 chosen communities from the list compiled by the extension agents resident in the areas selected thus comprising 120 cassava farmers interviewed for the study. Data were collected through the use of questionnaire and interview schedule.

Farm Budgetary Analysis was used to estimate the profitability of the cassava production; Stochastic Frontier Production Function was used to determine the technical efficiency of cassava farmers, while the elasticity of production and returns to scale was achieved from the result of the Stochastic Frontier Production Function of cassava farmers. Farm budgetary technique is expressed as:

$$\prod = TR - TC \qquad (1)$$
$$TC = TFC + TVC \qquad (2)$$
$$TR = PyQ \qquad (3)$$
$$GM = TR - TVC \qquad (4)$$
$$NI = TR - TC \qquad (5)$$
$$ROI = NI/TC \qquad (6)$$

Where

$\prod$ = Total Profit, TC = Total Cost, TR = Total Revenue, Q = Output

P_y = Price per unit of output, TFC = Total Fixed Cost, TVC = Total Variable Cost GM = Gross Margin, NI = Net Income, ROI = Return on Investment

The explicit specification of Frontier Production Function as used by Chukwuji, Inoni and Ike (2018) is given as:

$$Y_h t = \exp(X_h t\, \beta + V_h t - U_h t) \quad (7)$$

Where $Y_h t$ represents the output for the h^{th} farm at t-time period; $X_h t$ is a (1xk) vector of inputs for the h^{th} farm in the t-time period; β is a (kx1) vector of parameters that describe the transformation process; the $V_h t$ are assumed to be independent and identically distributed random error which have normal distribution with mean zero and unknown variance σ^2 and $U_h t$ are non-negative unobservable random variables associated with the technical inefficiency of production. Hence the presence of $U_h t$ implies that given the levels of inputs and technology, the observed output falls below its potential output.

The main strength of the stochastic frontier approach is that it deals with stochastic noise and permits statistical test of hypothesis pertaining to production structure and degree of inefficiency. Also, it provides a measure of technical efficiency for the same farm in each time period considered

However, the implicit form of the Stochastic Frontier Production Function model that specifies production efficiency of the cassava farmers is expressed as:

$$\text{Ln}\, Y = \beta_0 + \beta_1 \text{Ln}X_1 + \beta_2 \text{Ln}X_2 + \beta_3 \text{Ln}X_3 + \beta_4 \text{Ln}X_4 + V_i - U_i (8)$$

Where Ln = the natural logarithm
Y_i = Cassava output (kg/ha)
X_1 = Quantity of cassava stems/cuttings (bundles)
X_2 = Quantity of fertilizer used (kg)
X_3 = Labour use (man-day)
X_4 = Farm size (ha)
V_i = Symmetric error term accounting for random variation in output due to factors beyond the control of the farmer.
U_i = Non-negative random variables representing inefficiency in production relative to the stochastic frontier.
β_o = Intercept
β_1 - β_4 = Estimated coefficients

The determinants of technical efficiency were designed in terms of socio-economic variables of the cassava value chain actors. The relationship between technical inefficiency of cassava production and their socio-economic variables in the study area was defined by the model;

$$\sum [\exp(-U_i)] = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 Z_5 + \beta_6 Z_6 + \beta_7 Z_7 + \beta_8 Z_8 + \beta_9 Z_9$$

Where:
$\sum [\exp(-U_i)]$ = Technical inefficiency of cassava producers
Z_1 = Age of the cassava producers (years)
Z_2 = Number of years of formal education
Z_3 = Household size (no of persons)
Z_4 = Farming experience (years)
Z_5 = Off farm activities (full time farmer = 1; otherwise = 0)
Z_6 = Marital status (married = 1; single = 0)
Z_7 = Farmers' belonging to co-operative societies (members = 1; otherwise = 0)
Z_8 = Extension Contact (Yes = 1; Otherwise = 0)
β_0 = Intercept
$\beta_{1-}\beta_8$ = Variable coefficients

RESULTS AND DISCUSSION

The Socio-economic Characteristics of Cassava Farmers in the Study Area

Table 1: The Distribution of the Cassava-based Farmers According to their Socio-economic Characteristics in the Study Area

Variables	Frequency	Percentage
Age (years)		
20 – 29	13	10.8
30 – 39	21	17.5
40 – 49	38	31.7
50 – 59	25	20.9
60 – 69	15	12.5
70 – 79	8	6.5
Mean	**47**	
Gender		
Male	23	19.2
Female	97	80.8
Marital Status		
Single	5	4.2
Married	81	67.5
Widowed	26	21.7
Divorced	8	6.7
Education Level		
No formal education	8	6.7
Primary	26	21.7
Secondary	62	51.7
Tertiary	24	20
Mean	**12**	
Household Size		
1 – 5	46	38.4
6 – 10	69	57.4
11 – 15	5	4.2
Mean	**6**	
Years of Experience		
1 – 10	37	30.9
11 – 20	33	27.6
21 – 30	17	14.2
31 – 40	25	20.9
41 – 50	6	5
51 – 60	2	1.7
Mean	**21**	
Co-operative Membership		
Yes	19	15.8
No	101	84.2
Off Farm Activities		
Yes	62	51.7
No	58	48.3
Extension Contact		
Yes	12	10
No	108	90

Source: *Field survey, 2018*

Table 1 shows the age distribution of cassava-based farmers in the study area. From the results, the mean age of 47 was obtained. This indicates that cassava-based farmers were within the age bracket of (40 – 49) years. The implication is that majority of the cassava-based farmers are youths who energetic enough to actively participate in cassava production. This result is in agreement with Nandi, Guna and Yurkushii (2011) who stated that most farmers are in their economically active age group. It can be observed that females are more involved in the cassava production as revealed that 80.8% of the cassava-based farmers were females. Conversely, the result also shows that 19.2% of cassava-based farmers were males. The implication could be attributed to the fact that cassava is seen as a woman crop in the study area. This result conforms to the findings of Ezeibe, Edafiogho, Okonkwo and Okide (2015) who stated that female farmers were dominant participants in cassava production. Majority of the farmers 67.5% were married and 4.2% were single. This suggests that cassava-based farmers are mostly married. The implication is that the married cassava-based farmers would have more stable households who are better positioned to practice cassava production.

The result also shows that the mean level of education of the cassava-based farmers is 12 years and 51.7% of the cassava-based farmers attended secondary education, while 6.7% had no formal education. Education provides the necessary managerial skills to the farmers and enables them adopt innovations that could result to increased output. This is in line with the findings of Atagher and Okorji (2014) who stated that farmers with relatively high education levels are well equipped with the requisite knowledge of making better managerial decisions and are more aware on how to appropriately apply new technologies to increase output. The mean household size for the cassava-based farmers in the study area is 6 persons per head. The modal class of cassava-based farmers' household size is between 6 and 10 persons which is 57.4% of the farmers. This large household size has implications for farm hands which are of great importance to rural household who try to reduce cost by relying on their family members than hired workers (Ahmadu & Idisi, 2014). The cassava-based farmers were revealed to have mean years of experience of 20. This shows that the farmers are well experienced in cassava production. Also, 15.8% of the cassava-based farmers were members of a co-operative society while the 84.2% were not. This means that the greater proportion of the cassava-based farmers may not be able to reap the benefits that come from co-operative society. Membership to a co-operative society affords easy access to capital, improved technologies and information needed to maximize output (Onyenekwe, 2014).

The cassava-based farmers undertook cassava production as a primary activity as 51.7% of the farmers were more devoted to their cassava production than they did to off-farm activities. According to Ezeibe *et al.* (2015), farmers who engage more in other activities besides the farm work pay less attention to their farm but compensate for the failure as they have other sources of income which enables them to procure the necessary farm inputs for increased productivity. Majority of the cassava-based farmers (90%) had no contact with extension agents in the study area whereas 10% of the farmers had contact with extension agents. This implies that the non-frequent interface of the farmers with the extension agents might be as a result of insufficient number of extension staff in the study area, hence, disagrees with the opinion of Ndem and Osondu (2018) who noted that only 61.8% of the cassava farmers had no contact with the extension agents.

Costs and Return of Cassava-based Farming

Costs and Return of Cassava-based Farmers are presented in Table 2.

Table 1: Costs and Return of Cassava Production in the Study Area

Items	Quantity	Unit Price (₦)	Value (₦)/Hectare
Cassava tuber(48.8 kg per bag)	5899.9	22.54	289095.79
Revenue from sales of cassava stems (bundles)	79.78	300	52029
Total Revenue			**341124.79**
Cassava stems (bundles)	40.9	300	26706
Fertilizers in kg (50kg per bag)	120.5	163.33	42785.93
Labour (man-day):			
Clearing			
Ploughing			
Planting			
Weeding			
Fertilizer Application			

Source: *Field survey, 2018*

The result in Table 2 reveals that the total variable cost and the total fixed cost incurred by the cassava farmers are estimated to be N241,891.93 and N87,324.57 per hectare respectively. The highest cost incurred by the cassava farmers from all the total cost is labour cost (N172,400 per hectare), followed by the rent on land (N82,765 per hectare). The total revenue generated is N341,124.79 per hectare. The Gross Margin is N99,232.86 per hectare while the Net Income is N11,908.29 per hectare. The return on investment is 0.04, implying that in every N100 invested in cassava production; there was a return of N4. This implies that cassava farmers merely managed to remain in production, probably due to high cost of labour and rent on land which mount heavy decline on their profits. This however disagrees with the findings of Nwafor, Anosike, Adegbola and Ogbonna (2016) whose report implies that cassava farmers made N2.16 worth of profit in every N1 invested in cassava production.

Estimate of the Stochastic Frontier Production Function for Cassava Farmers

The Maximum Likelihood Estimation (MLE) and its associated Ordinary Least Square (OLS) results are presented in Table 3.

Table 2: Estimates of the Stochastic Frontier Cobb-Douglas Production Function for Cassava Farmers in the Study Area

Variables	OLS		MLE	
	Coefficients	Standard error	Coefficients	Standard error
Constant X_0	7.226 (8.704)*	0.8301	6.878 (10.71)*	0.6418
Cassava stems X_1	0.4226 (5.840)*	0.0724	0.3738 (6.087)*	0.0614
Fertilizer X_2	0.0756 (2.382)**	0.0317	0.0710 (2.357)**	0.0301
Labour X_3	-0.0376 (0.3177)	0.1184	0.0792 (0.8473)	0.0934
Farm sizeX_4	0.3244 (4.198)*	0.0773	0.3412 (5.136)*	0.0664
Determinants of Technical Inefficien cy				
Constant Z_0			0.9038 (3.260)*	0.2774
Age Z_1			0.0063 (0.5360)	0.0117
Level of education Z_2			-0.0671 (-0.7472)	0.0898
Household size Z_3			-0.1563 (-2.600)*	0.0601
Farming experience Z_4			-0.0183 (-0.6847)	0.0268
Off-farm activities Z_5			0.0919 (0.1266)	0.7258
Marital status Z_6			0.4706 (1.8535)***	0.2539

Source: *Field Survey (2018) using Statistical Software (Frontier Version 4.1c)*
Figures in parenthesis are t-ratios
* ; ** ; *** represent levels of significance at 1%, 5% and 10% respectively.