Economic Efficiency of Cassava Based Farmers in Southern Wetland Region of Cross River State, Nigeria: A Translog Model Approach

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Abstract

The study estimated translog stochastic profit function and economic efficiency model for cassava based farmers in Southern Wetland region of Cross River State, Nigeria. Two-stage random sampling method was used to select 120 cassava based farmers in the study area. Maximum likelihood estimates of the specified models revealed an average economic efficiency of about 0.58. The results further showed that level of farming involvement, farmer's education, ability to predict rainfall, farming experience, household size, soil management technique adopted, extension agent visits and farm size are significant determinants of profit efficiency of cassava based farmers in southern wetland region of Cross River State. To increase farmer's economic efficiency, farm-level policies aimed at improving farmer's education, reduction in production constraints and increase in extension agent visits; as well as increase private investment in the sub-sector, were recommended.

Key words: Economic, Profit, efficiency, farmers, cassava, wetland, Cross River State.

1.0. Introduction

Nigeria is basically an agrarian society; but is consistently faced with the challenge of inadequate food supply for her teeming population (Udoh, 2005). The issue on food insufficiency in the country is compounded by increase in upland crop cultivation often accompanied by marginal increase in output (UNDP/ World Bank, 1992). The country's food production growth rate has been low; currently, it is put at 2.3 percent per annum while food demand is about 3.5 percent per annum (CIA World fact book, 2004). The disparity between the growth rate in the country's food production and the domestic demand for food has lead to myriad of problems such as; widening gap between domestic food supply and demand; increase food importation and continuous increase in food prices as well as increase in poverty (FMAWRRD, 1988 and Ajibefun 2003). With the population of over 140 million and a growth rate of about 2.56% per annum (National Population Commission, 2012, CIA world fact book, 2013); there is an overwhelming need to increase agricultural production. Consequently, Nigeria is being enlisted as one of the most food insecure and poverty stricken countries in the World (Food Agricultural Organization, 2002).

With the current level of upland use intensification (Udoh *et al.*, 2011), accompanied by increase in desertification and urbanization as well as other forms of land uses, wetland area offers an alternative source of agricultural production, especially in the dry season. Cross River State is one of the States located in the South –South region of Nigeria. The State is endowed with a large expands of wetland of about 2,212 km^2 (Ibanga and Armon, 1992). The wetland area in the Southern Cross River State stretches from Bakassi region through Akpabuyo, Calabar South, Calabar municipality, to Odukpani and Akamkpa Local Government Areas. Farming activities have been going on in the wetland region of the State for ages and predominantly in small scale basis.

Crop production in the wetland region is mostly practiced between the months of November to early April before the full commencement of the raining season. The wetland supports varieties of short-lived crops like cassava, okra, cucumber, fluted pumpkin, pepper and water leaf among others. Cassava (*Manihot spp*) is one of the most popular food crops grown in the wetland region of Cross River State. The crop (cassava) has diverse functions among ethnic groups in Nigeria. Cassava root can be processed into granulated substances called "garri" that is consumed by almost every Nigerians. Cassava is important not only as food crop but more as a major source of income for rural households. Nigeria is currently the largest producer of cassava in the World with annual production of over 34 million tonnes of tuberous roots. Both rich and the poor farmers prefer to sell high quantities of cassava than other crops, probably due to high demand. The crop and its derivatives have excellent potentials in livestock feed formulation, textile industry, plywood, paper, brewing, chemicals, pharmaceutical and bakery industries (Sanni *et al.,* 2008; Adebowale *et al.*, 2008).

The leaves are edible while the roots are good sources of ethanol and are rich in minerals, vitamins, starch and protein (Adegbola *et al.*, 1978; Smith, 1992; Ravindran, 1992). Cassava production in the wetland region is affected by uncertainties of rainfall and other exogenous as well as endogenous constraints inherent in arable crop production. Agricultural input and output prices are highly unstable in the country and in view of the supply response of most food crops; the ability of the cassava farmers to adjust production following price cycling a times, seems like an illusion (Udoh and Idiong, 2000). To achieve optimum output and profit efficiency, resources have to be optimally and efficiently utilized. The ability of wetland cassava farmers to adopt new technology and achieve sustainable production depends on their level of profit efficiency, mostly determined by variable input and output prices as well as the cost of fixed factors of production. As such, in an environment of highly unstable factor and output price of staple crops, couple with elastic demand nature of some crop outputs and scarce resources mix available to farmers; some factors would operate to cause changes in farm level profit and its efficiency. What are these factors and the magnitudes of their effects on farm level profit efficiency constitute the empirical questions this study sought to answer. Many scholars have attributed the food problem situation in Nigeria to low level of resource productivity of farmers in the country (Ojo, 2004, Ogundari, 2007 and Akpan *et al.,* 2012). Thus, to assess the resource productivity of cassava farmers in the wetland region of Cross River State is one of the prerequisites for increasing agricultural productivity in the study area. Therefore, the need for sustainability of cassava production in the wetland region of the State justifies this study. Hence, the study estimates normalized stochastic profit function in addition to economic or profit efficiency function of cassava based farmers in the southern wetland area of Cross River State.

2.0. Literature Review

There are mixed scholarly opinions concerning economic efficiency of arable crop farmers in Nigeria. Asogwa *et al.,* (2006) assessed the technical efficiency of Cassava Farmers and Food Security Policy in Nigeria. The study discovered the significant relationship between technical efficiency and cassava output, farm income, processing cost, *gari* yield, gross margin, farming experience, education and extension contact of the sampled cassava farmers in the study area. Ogundari and Ojo (2007) examined the technical, economic and allocative efficiency of Small Farms in Osun State of Nigeria. The cost (economic efficiency) efficiency estimated differs substantially among sampled farmers, ranging between 0.325 and 0.952 with a mean value of 0.807. Adeyemo *et al.,* (2010) determined the economic efficiency of small scale cassava farmers in Ogun State, Nigeria. They discovered that age and farming experience contributed to the technical inefficiency while cost of fertilizer, cost of herbicides, membership of cooperative organization and the level of education enhanced the technical efficiency of farmers. Their results showed that efficiency of cassava growers ranged between 88.69 and 100 with a mean of 89.4.

Nandi *et al.,* (2011) examined economic potential of Cassava production in Obubra Local Government Area of Cross River State, Nigeria. They discovered that gender, capital, farm size, labour and non-farm incomes, education, farming experience and cassava cuttings are significant factors that affect cassava output among farmers in the study area. Akpan *et al.,* (2012) used the stochastic profit model to study the efficiency of homestead based Cassava farmers in Southern Nigeria. The maximum likelihood estimates of the specified models revealed an average economic efficiency of 61.22%. The study also found that farmer's education, experience, household size, level of farming involvement, extension agent visit, soil management method adopted by farmers and farm size, were significant factors that affect farm-level economic or profit efficiency in resource use among homestead based cassava farmers in the study area.

Ogunniyi *et al.*, (2012) studied the resource use efficiency among cassava farmers in Osun state. Collected data were analyzed using the Ordinary Least Square (OLS) regression analysis to estimate economic efficiencies and production elasticities of selected inputs. Empirical result on productivity of resource use revealed that farm size, labour, fertilizer and cassava cuttings were under-used while herbicide was over-used. Farm size and labour was found to be the most significant factor of production determining the value of output. Oladeebo and Oluwaranti (2012), analyzed the profit efficiency among cassava producers in south western Nigeria. The results showed that about 51% of cassava producers had formal education; about 50% had more than ten years of farming experience while the average age, household size and farm size of the respondents stood at 46 years, 8 people and 3 hectares respectively. Result of the analysis showed that the profit efficiencies of the farmers ranged between 20% and 91%, while the mean level of profit efficiency was 79% which suggested that, an estimated 21% loss in profit was due to a combination of both technical and allocative inefficiencies. The study further showed that, household size and farm size were the major significant factors that influenced profit efficiency, positively.

From the literature reviewed, most of the studies focused on the efficiency analysis of the upland crop farmers. This indicates that the existing knowledge on efficiency in wetland crops production especially the cassava production is highly limited in Nigeria. Also, majority of the researches on efficiency among cassava farmers delved into the technical efficiency aspect without due consideration of the profit efficiency. In addition, most of these researches were conducted in western and eastern part of the country and not the South- South region. Since the regions have ecological and climatic differences, similar result might not be applicable in all regions. Therefore, this study was designed specially to fill these identified gaps in cassava production in the South-South region of Nigeria. The study is justified for the fact that any policy or attempt targeted on increase cassava production might not achieve the full policy objective, if wetland production is not incorporated. This is due to the poor storage and processing system and rain fed dependent agriculture practiced in the country. Hence, cassava produced in wetland region would help to cushion the adverse effect of widening demand –supply gap of the commodity, especially during off-season and provides temporary employment to thousands of Nigerians.

3.0. Methodology

3.1 Study Area and Method of Data Collection

The study was conducted in the southern part of Nigeria, specifically in Odukpani Local Government Area of Cross River State. The area is in the rainforest belt of the country and is characterized by upland and wetland regions. Cassava is the predominant crop in the area and is usually planted as a mixed or mono cropping. Cassava based farmers in this study are regarded as those farmers that grew cassava either as sole cropping or in mixed with other crops. As in mixed cropping, it is expected that cassava should accounts for more than 50% of the total cropped area. Two-stage random sampling method was employed. First, three wetland communities were randomly selected. The second stage involved random selection of 40 cassava based farmers from each community. A total of 120 farmers were used for the data collection. Data were collected with the aid of well structured questionnaires and complemented by personal interviews.

3.2. Analytical Model

Economic or profit efficiency shows success of a given farm enterprise as it indicates the ability of a farm to obtain maximum profit from a given level of input and output prices including the level of fixed factors of production in the farm (Farrel, 1957). A farm is economically efficient in resource use, when it operates on the economic efficiency frontier. On the other hand, economic inefficient farm operates below the efficiency frontier. The profit function model for the economic efficiency analysis is stated as follows:

$$\pi^* = \pi/\rho = f(q_i, Z)exp(V_i - U_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (1)$$

Where

π^* = normalized profit of i_{th} farmer; π/ρ = description of the normalized profit, q_i = vector of variable inputs; Z = vector of fixed inputs; P = output price used to normalize variables in the model; π = farmer's profit defined as total revenue minus total cost of production (In this study cassava revenue consists of returns from the sales of cassava tubers and stems; while total cost consist of the cost of fertilizer, manure, labour and planting materials); exp $(V_i – U_i)$ = composite error term, as described in equation (3).

The economic efficiency of an individual farmer is derived as a ratio of the observed or actual profit to the corresponding frontier profit given the price of variable inputs and the level of fixed factors of production of that farmer. Mathematically, it is expressed as thus:

$$EE = \frac{Actual\, farm\, Profit}{Frontier\, Profit} = \frac{\pi_i}{\pi_i^*} = \frac{(q_i, Z)exp(V_i - U_i)}{(q_i, Z)exp(V_i)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (2)$$

Then

$$EE = \frac{exp(V_i - U_i)}{exp(V_i)} = exp\,(-U_i) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (3)$$

The stochastic error term consists of two independent elements: *"V" and "U"*. The symmetric element V account for random variation in profit attributed to factors outside the farmer's control. A one-sided component u ≤ 0 reflects economic efficiency relatives to the frontier. Thus when u = 0, it implies farm profit lies on the efficiency frontier (i.e. 100% economic efficiency) and u < 0 implies that the farm profit lies below the efficiency frontier. Both V and U are assumed to be independently and normally distributed with zero mean and constant variance.

3.3. Empirical Model

A multiple regression model based on the stochastic profit function which assumes a translog form was employed to determine the economic efficiency of cassava based farmers in the study area. The choice of translog stochastic profit function was based on the suitability of the model in estimating sole enterprise profit function as well as its excellent ability to analyze interactions among production inputs. The model is as shown below (Nwachukwu *et al.*, 2007):

$$\begin{aligned} In\pi_i^* = {} & \alpha_0 + \alpha_1 InCAS^* + \alpha_2 InFER^* + \alpha_3 InLAB^* + \alpha_4 InMAN^* + \alpha_5 InLAN \\ & + 0.5\alpha_6 InCAS^{*2} + 0.5\alpha_7 InFER^{*2} + 0.5\alpha_8 InLAB^{*2} + 0.5\alpha_9 InMAN^{*2} + 0.5\alpha_{10} LAN^2 \\ & + \alpha_{11} InCAS^* InFER^* + \alpha_{12} InCAS^* InLAB^* + \alpha_{13} InCAS^* InMAN^* + \alpha_{14} InCAS^* InLAN \\ & + \alpha_{15} InFER^* LAB^* + \alpha_{16} InFER^* InMAN^* + \alpha_{17} InFER^* InLAN + \alpha_{18} InLAB^* InMAN^* \\ & + \alpha_{19} InLAB^* InLAN + \alpha_{20} InMAN^* InLAN + V_i - U_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (3) \end{aligned}$$

The above model is a translog specification model used in the analysis, it contains interactive terms. Note variables are expressed in logarithm and are as defined below:

Where;

π* = normalized profit of ith farmer

CAS* = normalized price of cassava bundle (₦/kg), ∂ π*/ ∂ CAS < 0

FER* = normalized price of fertilizer (₦/kg), ∂ π*/∂ FER < 0

LAB* = normalized price of labour (₦/manday), ∂ π*/∂ LAB < 0

MAN* = normalized price of manure (₦/kg), ∂ π*/∂ MAN < 0

LAN = Area of land cultivated (ha)

Note: We used the output price to normalize variables described above.

Determinants of Economic Efficiency of Cassava Based Farmers in Southern Wetland Region of Cross River State, Nigeria

The determinants of economic efficiency of cassava based farmers was modeled following the socio-economic characteristic of farmers in the wetland and thus specified as follows:

$$\mu = \gamma_0 + \gamma_1 Age + \gamma_2 Gen + \gamma_3 \text{Invo} + \gamma_4 \text{Edu} + \gamma_5 \text{Cre} + \gamma_6 \text{Ran} + \gamma_7 \text{Exp} + \gamma_8 \text{Hhs} + \gamma_9 \text{Smg} + \gamma_{10} \text{Ext} + \gamma_{11} \text{Fms} + U_i \dots\dots\dots\dots\dots\dots\dots\dots. (4)$$

Where

μ = Economic Efficiency of ith farmer

Age = Farmer's age (year)

Gen = Farmer's sex (1 for male and 0 for female)
Invo = Level of involvement in farming (0 for part time, 1 for full time)
Edu = Level of education (years)
Cre = Credit usage (access = 1 an no access = 0)
Ran = Ability to predict rainfall (1 for yes, 0 for no)
Exp = Farming experience (year)
Hhs = Household size (number)
Smg = Soil management Technique (1 for mould, 0 for zero mould)
Ext = Extension services access (number of time).
Fms = Farm size (ha)
U_i = Stochastic error term.

Equation (3) and (4) were jointly estimated by maximizing the likelihood function using the computer program Frontier Version 4.1 (Coelli, 1994).

4.0. Results and Discussion

Table 1 showed the maximum likelihood estimates of the translog stochastic profit function of cassava based farmers in the southern wetland region of Cross River State. The result showed a sigma square coefficient of 0.7551 that is statistically significant at 1% probability level. This implies that, the equation has a good fit and confirms the correctness of the specified distribution assumption of the composite error term for the model. The variance ratio of 0.999 (significant at 1% level) indicates that about 99.9% of disturbance in the system is due to economic inefficiency, while 0.01% is due to the normal assumption econometric error. These diagnostic results confirm the presence of one sided error term in the specified model and reveal the appropriateness of the specified stochastic model as well as the choice of the maximum likelihood estimation technique. In addition, more than 50% of the second order explanatory coefficient variables in the estimated model are significant and exhibited *a priori* signs. This further validates the correctness of the specified translog form of stochastic profit function.

4.1. Maximum Likelihood Estimates of the Translog Stochastic Profit Function of Cassava Based Farmers in Wetland Region of Cross River State

The result as presented in Table 1, showed the first, second and third order coefficients of the explanatory variables in the estimated profit function. The first order coefficients are those of single factor of production; the second order coefficients are those of squared variables; while the third are the interactive variables. Among the first order coefficients, the result revealed that, the coefficient of price of cassava bundle, wage rate and price of manure have significant negative effect (i.e. at 1%, 10%, and 1% respectively) on the profit level of cassava based farmers in the study area. This implies that, increase in these variables would result to the reduction in profit level of cassava farmers in the study area. On the other hand, the elasticity of farm profit with respect to the land area is positive and significant at 1% probability level. This means that increasing the size of land will also increase the profit level of cassava farmers in the study area. Nwachukwu and Onyenweaku (2007) reported similar results in Imo state. The result further revealed that farmer's level profit has inelastic relationship with respect to the first order explanatory variables. This means that, 1% change in first order explanatory variables will result in a less than equivalent 1% change in the cassava farmers' level profit.

Also, farm level profit has significant negative inelastic relationship with respect to the second order coefficients (squared coefficients) in the model. The results imply that, continuous increase in the specified variables in the model will reduce significantly farm level profit of cassava based farmers in the study area. The result indicates that, the utilization of most of the specified factors of production occur in stage II or optimal stage in the classical production surface. Therefore, increase in the use of these inputs might push the production process to stage III, where diminishing marginal return, sets in. In addition, farm level profit has a mixed relationship with the third order coefficients (i.e. interactive coefficients) in the model. However, most interactive coefficients were significant (i.e. more than 50%) implying that, some specified variables combined to cause significant change in the farmer's level profit.

4.2. Profit Efficiency Model for Cassava Based Farmers in Wetland Region of Cross River State

Table 2 shows the result of factors that determine profit efficiency of cassava based farmers in the wetland region of Cross River State. The slope coefficient for the level of farming involvement (0.4506), education (0.4501), ability to predict rainfall (0.5153), farming experience (0.2927), household size (0.7655), soil management method (0.3788), extension access (0.4235) and farm size (0.6816) has positive significant effect at 1%, 1%, 1%, 1%, 5%, 1%, 5% and 5% respectively, on the farm-level profit efficiency of cassava farmers in the study areas. The result indicates that, increase in aforementioned variables would result in increase in the profit efficiency and decrease in profit inefficiency among cassava based farmers in the region. This means that, full - time cassava farmers have higher profit efficiency compared to part-time farmers. The result could be attributed to the ease of adoption of new technology and experience in forecasting price movement of cassava. The finding corroborates the report of Akpan *et al,* (2012).

Also, as a farmer's ability to predict rainfall pattern increases, the tendency to invest in the cassava cultivation in the wetland region also increases due to less anticipating risk of flood. While increase in household size of individual farmer increases the manday of family labour available to the farmer. This invariably means a reduction in variable cost and subsequent upsurge in profit level of such farmer. This result is in consonant with the research reports of Akpan *et al.,* (2012); Oladeebo and Oluwaranti, (2012). Furthermore, adoption of appropriate soil management technique (such as soil mould) and increase in extension agents' visits enhance the profit level of wetland farmers. The adoption of appropriate soil management technique is predicated by the pattern of rainfall which is also a function of a farmer's predictive ability. The findings agree with other similar findings reported by Akpan *et al,* (2012) and Asogwa *et al.,* (2006) for extension contact.

The coefficient of farmer's experience (0.2927) has a positive significant effect on the profit efficiency of cassava based farmers in the study area. The result implies that, farmers with many years of farming experience in wetland area have greater adoption tendencies than those with less years of experience. Similar result has been reported by Asogwa *et al.,* (2006); Adeyemo *et al.,* (2010) and Akpan *et al.,* (2012). Similarly, years of formal education and farm size of farmers have positive impact on profit efficiency of cassava farmers in the study area. Asogwa *et al.,* (2006); Adeyemo *et al.,* (2010); Oladeebo and Oluwaranti, (2012) and Akpan *et al.,* (2012) have reported similar result for education; while Oladeebo and Oluwaranti, (2012) and Akpan *et al.,* (2012) confirm the relationship for farm size.

4.3. Distribution of Profit Efficiency among Cassava Based Farmers in Cross River State

Table 3, shows the frequency distribution of economic (profit) efficiency of cassava based farmers in the wetland region of Cross River state. Cassava based farmers exhibited varied profit efficiencies ranging from 0.066 to 0.993 with a mean value of 0.580.

The results show that, considerable or significant amount of profit is lost (about 42%) from cassava production in the wetland region of Cross River State because of the existence of economic inefficiency in resource use among cassava farmers. This also implies that, significant quantity of cassava in the region is not produced due to profit inefficiency in resource use among farmers. The result revealed that few farmers (about 15%) are close to the profit or economic efficiency frontier while about 3.33% are very far from the efficiency frontier. However, the least economic efficient cassava based farmer, needs an efficiency gain of 94.06% (i.e. 1.0-0.066/0.993)100 in production, if such farmer is to attain the economic efficiency of the best efficient farmer in the region. Likewise for an average economic efficient farmer, he will need an efficiency gain of 42.3% (i.e. 1.0-0.58/0.993)100 to attain the most efficient level of production. Also, the most economic efficient farmer in the study area needs about 0.007% gains in economic efficiency to be on the frontier efficiency. The result had revealed profit inefficiency gap of about 42% in wetland cassava production in the study area. The findings call for a drastic policy options that should pay attention to the identified policy variables in this study.

5.0. Conclusion and Recommendations

The study estimated profit efficiency and determined factors affecting profit efficiency of cassava based farmers in wetland region of Southern Cross River State, Nigeria. Maximum likelihood estimates of the specified translog stochastic profit function and economic efficiency model revealed that individual farmer's level of efficiency range from 0.066 to 0.993 with an average of 0.580.

The results reveal that farmer's economic efficiency has not reached the frontier level. Therefore, cassava based farmers economic efficiency could still be increased by 42% using the most avoidable technology available to the farmers. Significant factors affecting economic efficiency of cassava based farmers in the wetland region of the state are: level of farming involvement, farmer's education, ability to predict rainfall, farming experience, household size, soil management technique adopted, number of extension agent visit and farm size. Based on the magnitude of profit efficiency estimates; the study has identified household size, farm size and ability of cassava farmers' to predict rainfall as the major significant determinants of profit efficiency among cassava farmers in the study area. The findings call for relevant farm-level policies targeted at promoting farming as a business, farmer's education, extension agent's visit and reducing production constraints as well as adopting sound soil management technique in wetland region of the State. Furthermore, the study strongly advocated for an increased private investment in cassava production especially in the wetland region, with an intention of replacing the present peasant system with market-oriented production. Finally, a good weather forecasting station should be established in the State to help farmers monitor and predict accurately the pattern of rainfall in the area.

Table 1: Maximum Likelihood estimates of the Translog stochastic profit function of cassava based farmers in wetland region of Cross River State.

Variable	Parameter	Coefficient	Std. error	t- value
Constant	α_o	0.2425	0.3304	0.734
Price of Cassava bundle	α_1	-0.1513	0.0461	-3.282***
Price of Fertilizer	α_2	-0.3228	0.8963	-0.360
Price of Labour	α_3	-0.7762	0.3921	-1.979*
Price of manure	α_4	-0.1945	0.0641	-3.034***
Area of Land	α_5	0.3955	0.1059	3.735***
Price of Cassava bundle square	α_6	-0.5772	0.2257	-2.557**
Price of Fertilizer square	α_7	-0.4402	0.2126	-2.071**
Price of Labour square	α_8	-0.7812	0.0734	-10.643***
Price of Manure square	α_9	-0.5232	0.1627	-3.216***
Area of Land square	α_{10}	-0.6535	0.1186	-5.510***
Price of Cassava b. X Price of fert.	α_{11}	-0.2203	0.7436	-0.296
Price of Cassava b. X Price of labour	α_{12}	0.2025	0.6121	0.331
Price of Cassava b. X Price of manure	α_{13}	-0.3947	0.1596	-2.473**
Price of Cassava b. X Area of land.	α_{14}	-0.4939	0.1991	-2.481**
Price of Fertilizer X Price of labour	α_{15}	-0.9745	0.5758	-1.692*
Price of Fertilizer X Price of manure	α_{16}	0.4511	0.0926	4.872***
Price of Fertilizer X Price of land	α_{17}	0.1305	0.1119	1.166
Price of Labour X Price of manure	α_{18}	-0.2374	0.1118	-2.123**
Price of Labour X Area of land	α_{19}	-0.6109	0.2947	-2.073**
Price of Manure X Area of land	α_{20}	0.6768	0.1352	5.001 ***
Diagnostic Statistics				
Sigma square	∂^2	0.7551	0.0494	15.285***
Gamma	λ	0.7909	0.0004	2499.75***
Log-likelihood function	-28.68			
LR Test	78.84			

Source: *Derived from data analysis 2012, model estimated by Frontier 4.1 MLE. Asterisks *, **, and *** represent significance levels at 10%, 5% and 1% level respectively. Variables are as defined in equation (3). Note; b means bundle.*

Table 2: Profit efficiency model of cassava based farmers.

Variable	Parameter	Coefficient	Std. error	t-value
Constant	γ_o	0.7586	0.4415	1.718*
Age	γ_1	-0.1468	0.6183	-0.237
Sex	γ_2	-0.11191	0.8113	-0.138
Level of farming involvement	γ_3	0.4506	0.0929	4.850 ***
Education	γ_4	0.4501	0.0957	4.708***
Credit	γ_5	-0.2552	0.7881	-0.332
Ability to predict rainfall	γ_6	0.5153	0.0938	5.494***
Farming experience	γ_7	0.2927	0.0704	4.158***
Household size	γ_8	0.7655	0.3200	2.392**
Soil management technique	γ_9	0.3785	0.0799	4.741***
Extension service	γ_{10}	0.4235	0.1634	2.592**
Farm size	γ_{11}	0.6816	0.3395	2.008**

***Source:** Frontier 4.1 estimates: Data from field survey 2012. Asterisks *, **, and *** represent significance levels at 10%, 5% and 1% level respectively. Variables are as defined in equation (4).*

Table 3: Frequency Distribution of Profit Efficiency of Cassava based Farmers.

Efficiency class	Frequency	Percentage
0.001 – 0.100	4	3.33
0.101 – 0.200	12	10.00
0.201 – 0.300	10	8.33
0.301 – 0.400	2	1.67
0.401 – 0.500	22	18.33
0.501 – 0.600	8	6.67
0.601 – 0.700	18	15.00
0.701 – 0.800	8	6.67
0.801 – 0.900	18	15.00
0.901 – 1.000	18	15.00
Total	**120**	**100.00**
Minimum Technical Efficiency	0.066	
Maximum Technical Efficiency	0.993	
Mean Technical Efficiency	0.580	

***Source:** From data analysis (2012), model estimated using Frontier 4.1 MLE.*

References

Adebowale A. A., O. L. Sanni, M. O. Onitilo (2008). Chemical composition and pasting properties of Tapioca Chips from different cassava varieties and roasting methods. *African J. Food Sci. Vol. 2: 77 – 82.*

Adegbola A. A., L. A. Ave, T. L. Ashaye, M. F. Komolate (1978). Agricultural Science for West African Schools and Colleges. Great Britain Cox and Wyman Ltd, London.

Adeyemo, R., J. T. Oke and A.A. Akinola 2010. Economic Efficiency of Small Scale Farmers in Ogun State, Nigeria. Tropicultura, 2010, 28, 2, 84-88.

Ajibefun I. A., (2003). Determinants of technical efficiency in traditional agricultural production: application of stochastic frontier modelling to food crop farmers in South-Western Nigeria. *African Journal of Economic Policy* Vol. 10(2); 31-56.

Akpan, S. B., Inimfon V. P., and Samuel James Udoka, (2012). Stochastic Profit Efficiency of Homestead based Cassava Farmers in Southern Nigeria. *Asian Journal of Agriculture and Rural Development, Vol. 2, No. 3, Pp. 498-505.*

Asogwa, B. C., J. C. Umeh and P. I. Ater (2006). Technical efficiency analysis of Nigerian Cassava farmers: a guide for food security policy. Poster paper prepared for presentation at the international association of agricultural economists conference, gold coast, Australia.

Awoniyi O. A., Bolarin T. O. (2007). Production Efficiency in Yam based Enterprise in Ekiti State, Nigeria. *Journal of Central European Agriculture Vol. 7 No. 4 Pp 626 – 635.*

Coelli T. J. (1994). A Guide for Frontier 4.1. A Computer Program for Stochastic Frontier Production and Cost Function Estimation. Department of Econometrics, University of New England Armidate, WSW, 235L, Australia.

Farrel M. (1957). The Measurement of Productive Efficiency, J. Royal Statistical Society, Rent 3:253-290.

Ibanga I. J., Armon, M. N. (1992). Report on the wetland Soil of Cross River State, Nigeria. Cross River State Agricultural Development Project, Calabar.

Nandi, J. A., Patience Gunn and Evans N. Yurkushi (2011). Economic Analysis of Cassava Production in Obubra Local Government Area of Cross River State, Nigeria. *Asian Journal of Agricultural Sciences 3(3): 205-209.*

NPC, (2006). National Population Commission, National Census data for Nigeria.

Nwachukwu I. N., Onyeweaku, C. (2007). Economic Efficiency of Fadama Telfairia Production in Imo State Nigeria. A Translog Profit Function Approach. *Munich Personal RePEc Archive (MPRA). Paper No. 13469.*

Ogundari K., (2006). Determinants of Profit Efficiency among Small Scale Rice Farmers in Nigeria. Paper Presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia.

Ogundari K., S. O. Ojo. (2007). Economic Efficiency of Small Scale Food Crop Production in Nigeria. A Stochastic Frontier Approach. *Journal of Social Science. 14(2): 123-130.*

Ogundari, K., and S. O. Ojo, (2007). An examination of technical, economic and allocative efficiency of Small Farms: The Case Study of Cassava Farmers in Osun State of Nigeria. *Journal of Central European Agriculture Vol., No. 3, Pp 423-432.*

Ogunniyi L. T, Ajao A. O, Olapade-Ogunwole F, and Ganiyu M. O., (2012). Resource-use Efficiency of Cassava Production in Atakunmosa Local Government Area of Osun State. Prime Journal of Social Science, Vol. 1(2), pp. 27-30.

Ogunniyi L. T. (2008). Profit Efficiency among Cocoyam Producers in Osun State, Nigeria. *International Journal of Agricultural Economics and Rural Development. 1 (1), Pp. 38-46.*

Oladeebo and Oluwaranti (2012). Profit efficiency among cassava producers: Empirical evidence from South - western Nigeria. *Journal of Agricultural Economics and Development Vol. 1(2):46-52.*

Pius C. I., O. E. Inoni, (2006). Determinants of Yam Production and Economic Sufficiency among small-holder Farmers in South-Eastern Nigeria .*Journal of Central European Agriculture. Vol. 7, No. 2 Pp. 337 – 342.*

Ravindran V. (1992). Preparation of Cassava leaf products and their use as animal feed. Roots, tubers, plantain and banana in animal feeding, FAO. *Anim. Prod. Health Paper, 95: 111 – 125.*

Sanni L. O., A. A. Adebowale; B. Maziya – Dixon; A. G. Dixon (2008). Chemical composition and pasting properties of CMD resistant cassava clones planted at different locations. *J. Food Agric. Environ., 6: 97-104.*

Smith, O. B. (1992). A review of ruminant response to cassava based diets. In Hahn S. K. Reynolds L., Egbunike G. N: *Cassava as livestock feed in Africa: pp 39 – 53.*

Udoh E. J. (2005). "Demand and Control of Credit Form Informal Sources by Rice Producing Female of Akwa Ibom State. Nigeria". *Journal of Agriculture and Social Sciences*. Vol. 1 (2) Pp.152-155

Udoh E. J., Idiong, C. I. (2000). Estimation of Normalized Profit Function and Factor Share EquationforCassava-Based Farmers in Odukpani Local Government Area, Cross River State. *International Journal of Social Science and Public Policy. Vol. 3 No.2, Pp201-208.*

Udoh, E. J., S. B. Akpan and Edidiong R. Effiong, (2011). Economic Analysis of Land Allocation Use and Intensification among Arable Crop Farmers in Uruan Local Government Area of Akwa-Ibom State, Nigeria. *Journal of Economics and Sustainable Development, Vol.2, No.11&12.*

UNDP/World Bank, Publication 1992. African Development Indicators.