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Full Length Research Paper

Evaluation of the socio-economic characteristics of cassava farmers and their profit efficiency: Empirical evidence from South western Nigeria

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This study examined the profit efficiency in cassava production with a view to isolating significant factors leading to variation in farm-specific profit inefficiencies among cassava producers, using Southwestern Nigeria as a case study. Cross sectional data obtained from 109 representative samples of cassava producers with the aid of structured questionnaire supplemented with oral interview were analyzed by the use of descriptive statistics to explain the socio-economic characteristics of the cassava producers and stochastic frontier profit function to estimate profit efficiency of cassava producers in the study area. 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 further 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 which influenced profit efficiency positively. The study concluded that there is scope for increasing profit efficiency in cassava production by directing policy focus on these profit efficiency factors.

Key words: Profit efficiency; cassava producers; South Western Nigeria.

INTRODUCTION

Agriculture in Nigeria is dominated by the small scale farmers who are engaged in the production of the bulk of food requirements of the country [Asogwaetal, 2006]. In spite of the fact that these small scale farmers occupy a unique and pivotal position, they belong in the poorest group of the population and as such cannot invest much on their farms Asogwa et al (2006). According to Ajibefun (2002), the vicious circle of poverty among these farmers has led to the unimpressive performance of the agricultural sector. Thus, resources must be used much more efficiently, which entails eliminating waste, thereby leading to increase in productivity and incomes [Ajibefun and Daramola, 2003].

Cassava (*Manihot Esculentuz* Crantz) is an important root crop in Nigeria. Nigeria is the largest producer of cassava in the world. Currently, production of cassava is put at about 34 metric tonnes a year [Raphael, 2008]. According to Food and Agricultural Organization (FAO) (2004), the total harvested area of the crop in 2001 stood at 3.125 million hectares with an average yield of 10.83 tonnes per hectare. Cassava serves as food for man as well as in feeding livestock animals. Man consumes over two thirds of the total production of cassava roots in various forms and the remainder is used as animal feed. The starchy, thickened storage roots are valuable source of inexpensive calories [Akanbi, 2004]. Cassava roots are consumed raw, boiled or processed into cassava flour which is used in many industries. Leaves are used as

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vegetable and can be harvested periodically throughout the growing season [Oladeebo et al., 2009]. As a result of its use as an industrial crop, cassava has been categorized as a cash crop to the extent that a

"Presidential Initiative on Cassava Production in Nigeria" was inaugurated with the aim of achieving on annual basis five billion dollars from export of cassava. Cassava could also be used in the production of ethanol which can be used as a compliment to petroleum. Thus, with these, cassava production capacity needs to be increased such that rising demand will be met. One of the ways by which this could be achieved is to improve the profits accruing to the producers.

According to ALi and Flinn [1989], profit efficiency, within a profit function context, is defined as the ability of a farm to achieve the highest possible profit, given the prices and levels of fixed factors of that farm. However, profit inefficiency is defined as profit loss from not operating on the profit frontier given farm specific prices and resource base.

Most efficiency studies on food crops and specifically cassava production in Nigeria were on technical efficiency measurement [Ajibefun, 2002; Raphael, 2008; Ojo, 2004; Aderinola et al., 2006], with little attention given to profit efficiency measurement. This study is necessary so as to contribute to literature on profit efficiency studies on food crops and especially cassava production with the attendant aim of improving the welfare of cassava farmers in Nigeria. The objectives of this study were to: (i) describe the socio economic characteristics of cassava farmers and, (ii) examine profit efficiency among cassava producers with a view to isolating significant factors leading to variation in farm – specific profit inefficiencies.

CONCEPT OF EFFICIENCY MEASUREMENT USING FRONTIER PROFIT FUNCTION

Farell [1957] in his pioneering study defined efficiency as the ability to produce a given level of output at lowest cost. Efficiency can be analyzed by its two components – technical and allocative efficiency. Technical efficiency is defined as the degree to which a farmer produces the maximum feasible output from a given bundle of inputs (an output oriented measure), or uses the minimum feasible of inputs to produce a given level of output (an input oriented measure). On the other hand, allocative efficiency relates to the degree to which a farmer utilizes inputs in optimal proportions, given the observed input prices [Rahman, 2003]. These components have been measured by the use of frontier production function which can be deterministic or stochastic. Deterministic frontier production function explains that all deviations from the frontier are attributed to inefficiency where as in stochastic frontier production function it is possible to discriminate between random errors and differences in efficiency [Rahman, 2003]. Yotopoulos et al. [1970] argued that a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowments [Ali and Flinn, 1989]. Thus, this led to the application of stochastic profit function models to estimate farm specific efficiency directly [Ali and Flinn, 1989; Rahman, 2003; Wang et al., 1996; Ogundari, 2006; Ali et al., 1994]. According to Ali et al. [1994] the profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any error in the production decision is assumed to be translated into lower profits or revenue for the producer.

Profit efficiency is defined as the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency is defined as loss of profit from not operating on the frontier [Ali and Flinn, 1989].

It should be noted that Battese and Coelli [1995] had extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. The advantage of their model is that it allows estimation of the farm-specific efficiency scores and the factors explaining efficiency differentials among farmers in a single stage estimation procedure. This study therefore, used Battese and Coelli [1995] model by postulating a profit function, which is assumed to behave in a manner consistence with the stochastic frontier concept. The model was applied to cassava producers in Oyo State, Southwestern part of Nigeria.

The stochastic frontier profit function is defined as:

$$\pi_i = f\left(P_{ij},\ Zik,\ Dij\right).\ \ Exp\ ej \qquad (1)$$

Where:

π_i is normalized profit of the ith farm and it is computed as gross revenue less variable cost divided by farm-specific cassava price; Pij is the price of the ith variable input faced by the jth farm divided by cassava price; Zik is level of the kth fixed factor on the j th farm; Dij are the dummy variables for soil conditions of the jth farm (D= 1 for fertile soils and 0 otherwise); ej is an error term which is assumed to behave in a manner consistent with the frontier concept [Ali and Flinn, 1989], that is

$$ej = V_i - U_i \qquad (2)$$

and i = 1, ………. N, is the number of farms in the sample. From Equation (2), Vis are assumed to be independently and identically distribution N (0, σ^2) two sided random errors, independent of the Uis; and the Uis are non-negative random variables, associated with inefficiency in production, which are assumed to be independently distributed as truncations at zero of the normal distribution with mean, $\mu i = \delta_0 + \sum_d \delta_d Wdi$ and variance $\sigma_{\mu 2}$ ($| N(\mu, \sigma u^2|$), where Wdi is the d^{th} explanatory variable associated with inefficiencies on farm i and δ_0 and δ_d are unknown parameters [Rahman, 2003].

The profit efficiency of farm i in the context of the stochastic frontier profit function is defined as:

$$PE_i = E\left[\exp\left(-\mu_i\right) \mid e_i\right] = E\left[\exp\left(-\delta_0 - \sum_{d=1}^{D} \delta_d W_{di}\right) \mid e_i\right]$$
……………………… (3)

PE_i lies between 0 and 1, and it is inversely related to the level of profit inefficiency. E is the expectation operator. This is achieved by obtaining the expectation μ_i upon the observed value of ei. The method of maximum likelihood was used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in term of the variance parameter $\sigma^2 - \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma u_2 / \sigma_2$ [Battese and Coelli, 1995].

MATERIAL AND METHODS

The study area

The study was conducted in Surulere Local Government Area of Oyo State in the south western part of Nigeria. The local government has ten wards which are Ba'iya Oje, Igbon/Gbambari, Iresa-Apa, Arolu, Iresaadu, Iregba, Iwofin, Oko, Ilajue and Mayin. Majority of the inhabitants are farmers with special interest in cassava food production. The study area enjoys tropical climate with two distinct seasons, which are the rainy and dry seasons. Agricultural production takes places mainly during rainy season which is between the months of April and October while the dry season is between the month of November and March. Other food crops grown in the study area are: maize, yam, cocoyam and rice while the major cash crops grown are cocoa, cashew and oil palm.

Method of data collection and sampling technique

The data used for this study were essentially from primary source, which are obtained from 120 representative cassava farmers from all the ten wards in the local governments. Simple random technique was used to select 12 cassava farmers from each of the ten wards in the local government areas. Data were collected with the use of well-structured questionnaire which were administered on the farmers coupled with oral interview. Eleven of the questionnaires were discarded for the analysis because they were not properly completed. The questionnaire was designed to gather data relating to yield of cassava, unit cost of labour per man day, farm size, inputs prices such as price per kilogramme of fertilizer, price per kilogramme of cassava stem, average price of agrochemical per litre and average price of farm implements/tools. Information on socio-economic variables such as years of education, membership of organization, household size, amount of credit used, amount of agrochemicals used and number of contact with extension agents by the cassava farmers.

Techniques of data analysis

Descriptive analysis was used to analyze the socio-economic characteristics of the selected cassava farmers in the study area, while stochastic frontier profit function specified in Equation (1) was used to analyze profit efficiency of the selected cassava farmers. The data collected on quantity of cassava harvested and cassava price were used to compute farm total revenue as PxQ, where P is the price of the output and Q is the quantity produced while the farm level profit (π) was computed as difference between the total revenue and total variable costs expended on producing the cassava, that is, Gross Margin= TR-TVC.

The explicit Cobb-Douglas functional form of the stochastic frontier profit function in equation (i) for the cassava farmers in the study area was therefore specified as follows:

$$Ln\pi_i = \ln\beta_0 + \ln\beta_1 P_{1i} + \ln\beta_2 P_{1i} + \ln\beta_3 P_{3i} + \ln\beta_4 P_{4i} + \ln\beta_5 D + vi - \mu i$$
…………… (4)

Where:

π_i is normalized profit (gross margin),
P_1 represents average price per man day of labour,
P_2 represents average price per kg of fertilizer,
P_3 represents average price of farm tools,
P_4 represents average price of agrochemicals,
D represents dummy for soil conditions.
Vi represents statistical disturbance term.
μi represents farmer specific characteristics related to profit efficiency.

The profit inefficiency model (μ_i) is defined by:

$$\mu_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i}$$
……………….(5)

Where:

Z_1 represents years of education,
Z_2 represents membership of farmer organization, Z_3 represents household size,
Z_4 represents amount of credit used in naira,
Z_5 represents amount of agrochemicals used in litres,

Table 1. Socio-economic characteristics of Cassava Farmers.

Characteristics	Operationalization	Frequency	Percentage
	No formal education	53	48.6
	Primary	44	40.4
Education	SSCE/Technical	4	3.7
	ND/NCE	5	4.5
	HND/BSc	3	2.8
	5 – 10	55	50.5
Farming Experience (years)	11 – 15	19	17.4
	16 and above	35	32.1
Average farming experience	13 years		
Average age	46 years		
Average household size	8 people		
Average farm size	3 hectares		

Source: Computed from survey data.

Z_6 represents farm size,

Z_7epresents number of contact with extension agents by farmers,

β's and δ's are the parameters to be estimated.

The level of education of farmers influences efficiency in agricultural production in terms of quality and quantity as well as the speed at which farmers adopt new technology and rationalize input to enhance output. Education represents human capital and it is hypothesized to have a positive impact on efficiency [Tijani et al., 2006]. Membership of farmer organization could facilitate easy access by farmers to cheap and quality farm inputs which could enhance output.

According to Tijani et al. [2006], access to credit provides the farmer with a means of expanding and improving his farm. It also determines the ease with which he adopts new practices and technologies in his enterprise. Therefore, lack of credit facility will have a negative effect on profit efficiency. The study by Wozniak [1993] supported this fact by reporting in his study that credit increases the net revenue obtained from fixed inputs, market conditions and individual characteristics, while credit constraint decreases the efficiency of farmers by limiting the adoption of high yielding varieties and the acquisition of information needed for increased productivity.

The maximum likelihood estimates of the parameters of the stochastic frontier profit function and the inefficiency model defined by (iv) and (v) are simultaneously obtained using FRONTIER 4.1 [Coelli, 1996].

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers

The socio-economic characteristics of the respondents are presented in Table 1. The table shows that majority of the cassava farmers (51.4%) had their level of education ranged from primary to university level. Through education, the quality of labour is improved and with it the propensity to adopt new techniques [Tijani et al., 2006; Hyuha, 2006]. Thus, cassava farmers in the study area would easily adopt new technologies which could improve their level of profit *ceteris paribus.*

The highest percentage of cassava farmers (50.5%) had their farming experience ranged between 5 and 10 years while the average years of experience stood at 13 years. As one gets proficient in the methods of production, optimal allocation of resources is expected to be achieved. The more experienced one is the higher the profit and the lower the profit inefficiency. Thus, the average years of experience (13 years) obtained is an indication of the fact that the cassava farmers in the study area were well experienced in farming, thus their level of profit inefficiency should be low. The average age of 46 years obtained for the cassava farmers indicate that they were still in their active productive years which could lead to low level of profit inefficiency. The average household size of 8 people obtained is an indication of large family size which implies availability of family labour to the farmers while the average farm size of 3 hectares obtained showed the small scale nature of farming business in the study area.

Profit efficiency estimation

Maximum likelihood estimate (MLE) of profit frontier function

Table 2 shows the MLE estimates of equations (iv) and (v). The table shows that the coefficients of the estimated parameters of the normalized profit function based on the assumption of competitive input and output markets were

Table 2. Maximum likelihood estimates of the stochastic profit frontier function for cassava production in Southwestern Nigeria.

Variables	Parameters	Coefficient	t-ratio
General models			
Constant	β_0	3.97	3.92
Average price per mandays of labour (P_1)	β_1	-0.00043	-0.31
Average price of fertilizer (kg) (P_2)	β_2	0.00052	1.20
Average price of farm tools (Kg) (P_3)	β_3	0.000012	0.42
Average price of agrochemicals (P_4)	β_4	1.66*	2.66
Soil Dummy	β_5	-1.50*	-2.30
Inefficiency Model			
Constant	δ_0	3.67	2.68
Education level (years)	δ_1	-0.049	-0.42
Membership of Organization	δ_2	0.087	0.095
Household Size	δ_3	-0.0081*	-2.22
Amount of Credit used	δ_4	0.000025*	6.57
Amount of agrochemicals used	δ_5	0.22*	2.16
Farm size	δ_6	-1.25*	-3.54
Extension contact	δ_7	0.023	0.072
Sigma squared	σ^2	7.51*	2.15
Gamma	γ	0.085	1.11
LR		-255.53	

* means significant at 5%. Source: survey data analysis.

positive except the cost of labour and soil dummy as expected. This implied that a unit increase in the prices of inputs with positive coefficient will lead to increase in the normalized profit of cassava and vice versa. However, the coefficient for cost of agrochemicals with positive coefficient of 1.66 was statistically significant at 5 percent level of significance and this appears to be the most important variable determining profit efficiency. This implies that for a 10 percent increase the use of agrochemicals, the profit obtainable from cassava production will increase by 16.6%.

In addition, the estimated sigma squared (σ^2) of 7.51 which was significant at 5% level of significance indicated a good fit of the model [Rahman, 2003; Ogunniyi, 2008]. The estimate of gamma (γ) of 0.085 obtained indicated that about 9 percent of the variation in profit among cassava farmers was due to differences in farmers' practices rather than random variability. The parameter estimates for determinants of profit efficiency were reported in the lower part of Table 2. The analysis of inefficiency models showed that the signs and significance of the estimated coefficients in the inefficiency model have important implications on the profit efficiency of the cassava farmer.

In the light of this, household size and farm size which were significant at 5% level of significance and negatively signed in the inefficiency model indicated that as these variables increase the profit efficiency of the cassava farmers' increases or the profit inefficiency of the cassava farmers decreases, while the coefficients with positive signs indicated that as these variables increase, the profit efficiency of the cassava farmers decreases or the profit inefficiency of the cassava farmers increases.

If the household size increases, this could provide the needed family labour force for cassava production since cassava production is labour intensive [6], hence, there will be improvements in the profit obtained other things being equal. Also, the negatively signed and significant coefficient of farm size at 5 percent level of significance points to the fact that cassava farmers were operating at small scale level, hence increasing their farm size will improve profit, other things being equal.

Deciles range of profit efficiency estimates of cassava farmers

Table 3 presents the distribution of profit efficiency of cassava farmers. The profit efficiency score ranged between 0.17 and 0.99 with an average of 0.79. The average profit efficiency score of 0.79 implied that an average cassava farmer in the study area could increase profits by 21% by improving technical and allocative

Table 3. Distribution of profit efficiency indices among cassava farmers in the study area.

Efficiency Index interval	Frequency	Percentage
Equal or less 0.20	2	1.83
0.21 – 0.30	1	0.92
0.31 – 0.40	4	3.67
0.41 – 0.50	10	9.17
0.51 – 0.60	4	3.67
0.61 – 0.70	10	9.17
0.71 – 0.80	16	14.68
0.81 – 0.90	26	23.85
0.91 and above	36	33.03
Total	109	100.0
Mean efficiency = 0.79		
Minimum efficiency = 0.17		
Maximum efficiency = 0.99		

Source: Survey data analysis.

efficiency in cassava production. This result conformed to the findings of Rahman [2003] and Ojo et al. [2009] who reported mean profit efficiency levels of 0.77 for Bangladeshi rice farmers and 0.78 for Nigerian cowpea farmers respectively. It could be seen in Table 3 that despite the variation in efficiency, about 81% of cassava farmers seemed to be skewed towards efficiency level of 61% and above, while the worst of these farmers obtained a profit efficiency score of 0.17 In spite of this, the results implied that a considerable amount of profit can be obtained by improving technical and allocative efficiency in cassava production in the area.

Conclusion

This study estimated the profit efficiency of cassava farmers in the southwestern part of Nigeria. Data obtained were analyzed by the use of descriptive statistics and stochastic Cobb-Douglas profit frontier model. Majority (about 51 percent) of cassava farmers were educated in formal institutions of learning while a substantial percentage of them (50 percent) had more than ten years of farming experience. The average farm size of 3 hectares obtained for the farmers suggested small scale nature of cassava production. Results of profit efficiency analysis showed that profit efficiency ranged between 20% and 91%, and the mean profit efficiency level of cassava farmers was 79% which suggested that an estimated 21% loss in profit was due to a combination of both technical and allocative inefficiencies in cassava production. Thus, an average cassava farmer could increase profit by 21% by improving their technical and allocative efficiencies. Major significant factors that affected cassava farm-specific profit inefficiencies were household size, amount of credit used, amount of agrochemicals used as well as farm size. The distribution of the profit efficiency indices showed that cassava farmers were fairly efficient in their resource allocation based on the fact that more than half of the farmers (about 72%) had profit efficiency indices of 0.71 and above. The study concluded by inferring from the results obtained that there is scope for increasing profitability of cassava production in the study area and Nigeria as a whole by directing policy focus on the significant inefficiency factors

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