Profit Efficiency among Cocoyam Producers in Osun State, Nigeria

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Abstract: This paper employs a translog stochastic frontier model to examine the profit efficiency of cocoyam production in Osun State, Nigeria. Farm-level data were collected from a sample of 120 cocoyam farmers. The average profit efficiency level was 12 percent. The result from the translog frontier profit function shows that corm and dummy variable for soil are important factors explaining changes in profit. The result also shows that family size, farm size, mulch and credit contribute negatively to loss of profit while farming experience tends to increase loss of profit. Loss of profit in cocoyam production can be reduced significantly by increasing farm size, using of mulch and having better access to credit.

Keywords: cocoyam; profit efficiency; stochastic frontier function;

INTRODUCTION

Cocoyam, Taro (*Colocasia esculenta*) is one of the most important crops in Nigeria. It has been reported to be the third most important staple root / tuber crop after yam and cassava in Nigeria, second to cassava in Cameroon and first in Ghana (Knipscheer and Wilson, 2000; Echebiri, 2004). In term of volume of production, Nigeria is the largest producer in the world, accounting for about 40% of the total production (Onwueme, 1978; Eze and Okorji, 2003). However, Onwueme (1991) noted that the global average yield is only about 6000kg/ha. It is the most widely cultivated crop in both western and eastern region of the country in terms of area devoted to it and number of farmers growing it. Indeed, almost every household grow it. Farmers need to be more efficient in their production activities, but also to be responsive to market indicators, so that scarce resources are utilized efficiently to increase productivity as well as profitability, and ensure supply to the urban market. Therefore, the principal solution to increasing food production lies in raising the productivity of land by closing the existing yields gaps and developing varieties with higher yield potential.

Cocoyam is important, not only as food crops but even more as a major source of income for rural households. In Nigeria, cocoyam is mostly produced in the eastern region e.g. Imo-state and western region e.g. Osun State. Cocoyam is composed of 70-80% water, 20 – 25% starch and 1.5- 3% Protein and significant amount of vitamins and its protein content is very high compared with that of other tropical tuber crops (Onwueme, 1991).

As a food crop, cocoyam has some inherent characteristics, which makes it attractive, especially, to the producer in Nigeria. Firstly, it is rich in carbohydrates, especially starch and consequently has a multiplicity of end uses. Secondly, it is available all the year-round, making it preferable to other, more resistant to drought, pest and diseases and it's tolerance of a variety of climatic and soil conditions on the farm. It is one of the recognised crops in Osun State. Apart from the tuber, other parts of the cocoyam plant are of domestic significance. For instance, the leaves and petioles, may be cooked and eaten as a vegetable, According to above state, taro is a valuable staple carbohydrate food, relatively easy and inexpensive to produce. It has become a staple food for most Nigerians, not only among rural people but also among the urban dwellers (Wilson, 1980).

Compared to grains, cocoyam is more tolerant in low soil fertility and more resistant to drought, pests and diseases. Furthermore, its roots are storable in the ground for months after they mature. Where cocoyam production system aim to produce human food, animal feed or industrial raw materials, yield is not the only objective. A further qualification of the earlier simple objective is that money is often the ultimate product which is required from the system through the sale of the crop materials. Profit from the system and an adequate return on investment are important considerations. Maximum yield may not be a sensible objective of the level of inputs required to produce high yields results in uneconomic returns. Efficiency in the use of financial resources in growing crops is an important factor. This can be expanded by emphasising the need to market the crops in such a way as to maximize returns (Harper, 1999). As noted by Zubair and Hunter (2000), the cultivation of cocoyam is not encouraging as the yield per hectare is still low. One of the reasons for the low yield may not be unconnected to dismal and little attention farmers give to cocoyam when compared with cassava and yam that are close substitute root/tuber crops. According to NRCRI (2003), the ignorance of the nutritive value and diversities of the food forms from cocoyam by a large percentage of the populace is a major limiting factor to general acceptability and extensive production of the crop.

For profit efficiency of cocoyam farmers to be increased, there is need for the qualitative extension services among farmers. Their performance and interest in this respect have to be raised. However, events of the past decade have shown that many Nigerian farmers neither perform well despite having access to extension services. Cocoyam farmers can be helped to obtain high yield through introduction of modern and effective farm technologies and improved varieties by the extension services, which bring about expected result to the farmer. The objective of the study therefore, was to examine the profit efficiency among cocoyam producers in Osun State, Nigeria, and identify the sources of loss of profit/loss among cocoyam farmers.

Concepts of Profit Efficiency

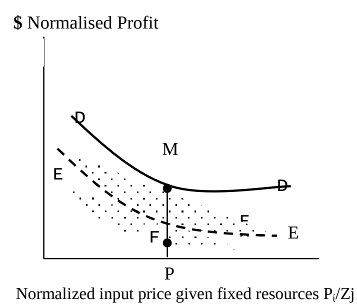
The question of how to measure efficiency has received considerable attention in economic literature. A profit function is an extension and formalization of the production decisions taken by a farmer. According to production theory, a farmer is assumed to choose a combination of variable inputs and outputs that maximize profit subject to technology constraint

(Sadoulet and De Janvry, 1995). Following the work of Farrell(1957), efficiency can be defined as the ability to produce a given level of output at lowest cost. The concept of efficiency has three components: technical, allocative and economic. Technical efficiency is defined as the ability to achieve a higher level of output, given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficiency decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical and allocative efficiencies are components of economic efficiency (Abdulai and Huffman, 1998).

Lau and Yotopoulos (1971) and Yotopolous and Lau (1973) therefore popularized the use of the profit function approach, in which farm- specific prices and levels of fixed factors are incorporated in the analysis of efficiency. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use.

Adesina and Djato(1996) defined profit efficiency as the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm. Aigner *et al* (1977), however, showed that profit function models do not provided a numerical measurable of firm-specific efficiency and popularised the use of the translog production frontier approach. The stochastic frontier approach has gained popularity in firm- specific efficiency studies. Example of recent application includes (Ali and Flinn, 1989; Kumbhakar and Bhattacharyya, 1992; Ali *et al*, 1994).

Figure 1 shows the stochastic profit frontier function adopted from Ali and Flinn (1989).The stochastic profit frontier function is an extension of incorporating farm level prices and input use in the frontier production function. The incorporation of the farm specific level prices leads to the profit function approach formulation Ali and Flinn, 1989; Wang *et al*, 1996). A production approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowment (Ali and Flinn, 1989). Hence the use of stochastic profit functions to estimate farm specific efficiency directly (Ali and Flinn, 1989; Ali *et al*, 1994; Wang *et al*, 1996). The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationships and any errors in the production decision translate into lower profits or revenue for the producer (Rahman, 2003). 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 in this context is defined as the loss of profit from not operating on the frontier (Ali and Flinn, 1989).



Source: Ali and Flinn, 1989

Figure 1: Frontier MLE and OLS Stochastic Profit Function

In the context of frontier literature, DD in figure 2 represents profit frontier of farms in the industry (the best practice firm in the industry with the given technology). EE is the average response function (profit function) that does not take into account the farm specific inefficiencies. All farms that fall below DD are not attaining optimal profit given the prevailing input and output prices in the product and the input markets. They are producing at allocativelly inefficient point F in relation to M in Figure 1. Profit inefficiency is defined as profit loss of not operating on the frontier. In Figure 1, a firm operating at F, is not efficient and its profit inefficiency is measured as FP/MP (Ali and Flinn, 1989; Sadoulet and De Janvry, 1995).

In agriculture, a farmer has to pay attention to relative prices of the inputs such that the production is undertaken at the point where the isoquant is tangent to isocost line. If that is not done, economic efficiency is not achieved. The farmer may be able to achieve technical efficiency but not allocative efficiency. This inefficiency could arise from a number of sources, which include access to appropriate information in a timely manner or lack of skills to take advantage of modern agricultural inputs. Basically, what is being referred to here is the managerial ability of the farmer. The farmer should be able to make decisions that lead to optimal utilization of resources and this requires accurate information on availability of the new varieties, the inputs, and access to markets

METHODOLOGY

The study was carried out in Osun State of Nigeria. The state is one of the 36 states in Nigeria. It is located in the southwestern part of the country. The state has a land area of 8802 square kilometres and a population of 3,423,535 (NPC, 2006). The state is agrarian and well suited for the production of permanent crops such as cocoa and oil palm and arable crops (maize, yam, cassava and cocoyam) because of favourable climatic conditions. The annual rainfall is between 1000mm and 1500mm with daily temperature of about 30^0C. The people live mostly in organized settlements, towns and cities.

The data for this study were primary data collected from 120 cocoyam farmers selected from Atakumosa East and Atakumosa West Local Government Areas (LGAs) of Osun State, Nigeria. The sampling procedure used was multistage sampling technique. The first stage involved a purposively sampling of the two LGA based on the population of the cocoyam farmers and size. The second stage involved a simple random selection of 60 respondents from each LGA. Data were collected with the use of a structured questionnaire designed to collect information on the output, inputs, prices of outputs and inputs and some socio-economic characteristics of the farmers in the study area (education, experience and family size).

Descriptive statistics (mean, minimum and maximum) and stochastic frontier profit function were used to analyze the socio-economic characteristics and profit efficiency respectively.

The implicit general from of the translog profit frontier is defined as:

π = f (p_1, p_2, p_3, z_1, D) exp ej …….. (1)

Where

π = normalized profit (#) defined as gross revenue less variable cost, divided by price of output (p_y).

P_1, normalised price of mulch (#) computed as total expenditure on much divided by price of output (p_y)

P_2, normalised wage of labour as total expenditure of labour divided by price of output (p_y)

P_3, normalised price of corm (#) as total expenditure on corm divided by price of output (p_y)

Z_1 depreciated charges on farm implements

D soil dummy (D = 1 for fertile soil and 0 for problem soils)

Ej error term defined as v-u …………….. (2)

The model specified as equation (i) was first estimated using ordinary least squares (OLS) techniques. The estimates of the partial regression coefficients, and σ^2 were used as starting values for the maximum likelihood estimation (MLE) of the model.

The profit efficiency of the j^{th} farm is given by exp (-uj) or profit inefficiency by exp (1-exp (-uj).

Profit loss due to inefficiency was then calculated as maximum profit at farm – specific prices, fixed factors, and soil dummies multiplied by farm- specific profit inefficiency. Profit loss is defined as the amount that has been lost due to inefficiency in production given prices and fixed factor endowments and is calculated by multiplying maximum profit by (1-Pe)

Maximum profit per hectare is computed by dividing the actual profit per hectare of individual farms by its efficiency score.

PL = maximum profit (1-PE)

Where PL =Profit loss

PE = profit efficiency.

To identify factors associated with profit loss, ordinary least squares (OLS) multiple regression model was estimated.

PL =f (Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7,e)

Where Z_1 is the years of schooling;Z_2 is the years of farming experience; Z_3 is the family size; Z_4 is the total area of land (ha); Z_5 is the family labour used (mandays); Z_6 is mulch used (kg); Z_7 is credit use (dummy variable 1 for own capital, 0 for borrowed capital); and e is error term.

A linear function, using profit loss as the dependent variable, was estimated to determine the significance of these factors to profit inefficiency.

RESULTS AND DISCUSSION

Estimation of Profit Function

The OLS and MLS estimates of Equation (1) on a per hectare basis are presented in Table 1. The estimated partial regression coefficients is similar between the OLS and MLE models, as expected, the intercept is higher and standard errors are lower for the MLE estimates. The result of the analysis shows that corm and dummy variable for soil were statistically significant at 1%. This indicates that corm is an important factor explaining changes in profit. Also the dummy variable has an inverse relationship with profit implying that the more the use of good soils the lesser the profit.

The estimated sigma- squared (σ^2) is significantly different from zero at the 5% level. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. The observed significance of σ^2 at the 5% level conforms to (Hjalmarson *et al*, 1996; Sharma *et al*, 1999; Rahman, 2003). This suggests that conventional production function is not an adequate representation of the data. Moreover, the estimate of gamma (γ), which is the ratio of the variance of farm-specific profit efficiency to the total variance of profit, is 0.948. This means that more than 94.8% of the variation in profit among the farms is due to differences in profit efficiency.

Table 1: OLS and Maximum Likelihood Estimate of Profit Frontier Function.

Variables	OLS	MLS
Constant	2398.23(839.42)	2402.56(840.69)
Ln P_1	-1.38 (-0.45)	-1.67(-0.74)
Ln P_2	-0.044(-0.031)	-1.48 (-1.22)
Ln P_3	7.86(3.03)*	8.68(4.26)*
Ln Z_1	-11.62(-1.26)	-4.92(-0.53)
D	-203.52(-7.44)*	-224.57(8.38)*
½ Ln P_1^2	0.54(3.04)*	0.411(2.94)*
½ Ln P_2^2	-0.042(-0.81)	0.0054(0.11)
½ Ln P_3^3	0.064(0.26)	-0.018(-0.084)
½ Ln z_1^2	1.04(1.59)	0.54(0.99)
½ D	1.83(1.60)	1.18(1.30)
Ln P_1 LnP_2	-0.039(-0.21)	0.029(0.21)
Ln P_1 LnP_3	-0.048(-0.17)	-0.089(-0.37)
Ln P_1 LnZ_1	-0.15(-0.38)	-0.031(-0.11)
Ln P_1 D	-1.19(-1.91)**	-0.74(-1.50)
Ln P_2 LnZ_3	0.073(0.43)	0.060(0.44)
Ln P_2 LnZ_1	0.029(0.20)	0.14(1.10)
Ln P_2 D	0.058(0.40)	0.066(0.59)
Ln P_3 LnZ_1	-1.01(-3.37)**	-1.05(-3.53)*
Ln P_3 D	0.028(0.80)	0.38(1.44)
Ln Z_1 D	-0.48(-1.03)	-0.70(-1.69)***
Log likelihood	-414.60	-405.00
σ^2		344.17(2.08)**
R^2	0.700	

Source: Data analysis, 2007

Figure in parentheses are the t – value
* Estimates are significant at 1% level of significance
** Estimates are significant at 5% level of significance
*** Estimates are significant at 10% level of significance

Profit Efficiency

The distribution of profit efficiency of cocoyam production is presented in Table 2. The profit efficiency ranged between 0.000187 and 0.429 with an average of 0.12. The average profit efficiency score of 0.12 implies that the average farm producing cocoyam could increase profits by 88% by improving their technical and allocative efficiency. Farmers exhibit a wide range of profit inefficiency ranging from 57.1% to 99.9%. Ohajianya (2005) reported mean profit efficiency level of 0.32 for cocoyam producers in Nigeria. Rahman (2003) reported mean profit efficiency level of 0.77 for Bangladesh rice farmers. The Table also shows that majority (35%) of the respondents have profit efficiency less than 0.05 while just 2.5% had between 0.36 and 0.45 profit efficiency.

Table 2: Frequency Distribution of Profit Efficiency for Cocoyam Farmers in the Study Area

Profit Efficiency	Frequency	Percentage
<0.05	42	35.0
0.06-0.15	41	34.2
0.16-0.25	20	16.7
0.26-0.35	14	11.7
0.36-0.45	3	2.5
Mean	0.120	
Minimum	0.000187	
Maximum	0.429	

Source: Field survey, 2007

Frequency Distribution of Profit Loss

Estimation of profit-loss given prices and fixed factor endowments revealed that cocoyam farmers are losing to the tune of N71,738.98k, which could be recovered by eliminating technical and allocative inefficiency. Majority of the respondents (33.3%) showed a profit loss of more than N 60,000 while 25% had profit loss of between 0 and N10,000. The largest farm- specific profit loss was N271,568.94k (Table3)

Table 3: Frequency Distribution of Profit Loss by Cocoyam Farmers in the Study Area.

Range of profit-loss (N / ha)	Frequency	Percentage
0-10,000	30	25.0
10001-20,000	21	17.5
20001-30,000	12	10.0
30001-40,000	7	5.8
40001-50,000	8	6.7
50001-60,000	2	1.7
> 60000	40	33.3
Mean	71738.98	
Minimum	44.99	
Maximum	271,568.94	

Source: Field survey, 2007

Determinants of Profit Loss

The OLS estimates of the relationship between loss of profit and farm household characteristics is presented in Table 4. The result showed that there is a significant and negative relationship between experience and loss of profit. This implies that cocoyam farmers with more years of experience exhibited significantly more loss of profit than farmers with less years of experience. Farmers with more family size exhibited significantly less loss of profit than farmers with less family size. Large farms did not exhibit a significantly higher profit loss than smaller farms, a finding consistent with those of (Saleem, 1978; Bravo, 1984; Ohajinya, 2005). Farmers who used mulch experienced significantly less loss of profit than farmers who did not use mulch. Credit non availability contributed significantly to higher loss of profit among cocoyam farmers.

Table 4: Determinants of Profit Loss by Cocoyam Farmers in the Study Area

Variables	Coefficients	t-ratio
Constant	19951-695	1.234
Education	-3369.830	-0.959
Experience	-555.706	-2.269**
Family size	2795.934	2.126**
Farm size	32649.081	11.836*
Labour	2.577	0.346
Mulch	38063.789	5.224*
Credit	20117.7	2.975*
R^2	0.918	
F-value	180.248*	

Source: Result from data analysis, 2007.

* Estimates are significant at 1% level of significance

** Estimates are significant at 5% level of significance

CONCLUSION AND RECOMMENDATION

The study results from the regression analysis showed that the major variables affecting loss of profit were experience, family size, farm size, mulch and credit availability. Years of experience has a negative influence on loss of profits. The study results also showed that the majority of cocoyam farmers were not operating on the profit frontier, given the technology and that there was potential to do so by eliminating the observed inefficiencies. Loss of profit in cocoyam production can be reduced significantly by increasing farm size, using of mulch and having better access to credit. Also, measures to promote effective soil fertility management will improve efficiency.

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