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Application of the Normalized Profit Function in the Estimation of the Profit Efficiency Among Smallholder Farmers in Atiba Local Government of Oyo State

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Abstract: This study was carried out in Atiba Local Government Area of Oyo State. The main objective was to analyses gender and profit efficiency among small holder farmers. The data was collected from 120 smallholder farmers with the use of structured questionnaire. The data collected was analyzed using descriptive statistics, budgeting techniques and stochastic frontier profit function to estimate the profit efficiency of the small holder farmers in the study area. The maximum likelihood estimate of the profit frontier function reveals that labour has a positive and significant relationship with profit in male and pooled data, while it is insignificant in female respondents, which indicate that labour is an important factor explaining changes in profit among the female smallholder farmers. Also, equipment has a significant but negative relationship with profit in male, female and pooled data. This implies that equipment is negative factor that influences profit in the study area. The profit efficiency ranged between 0.062 and 0.963 with a mean of 0.447 for the male farmers. This means that, the average farmers could increase profits by 55.3% by improving their technical and allocative efficiency. Most of the farmers are faced with problem of capital (27.2 and 34% for male and female, respectively), while other problem faced by the smallholder farmers are cost of transportation, lack of storage facilities, lack of good roads high cost of labour and cost of chemicals.

Key words: Normalized, smallholder, profit, frontier, function, efficiency, Nigeria

INTRODUCTION

Nigeria is predominantly an agrarian country with over 70.0% of its population engaged in farming (CBN, 1996). Agriculture provides the bulk of employment, income and food for the populace. Also, it provides raw materials for the agro-allied as well as market for industrial goods. It deals in the cultivation of land for the purpose of producing food for man, feed for animals and fiber or raw material for our industries.

In Nigeria, food crop production remains a major component of all production activities in the agricultural sub-sector. Food-crop production comes under different agricultural systems. Most commonly are mixed farming, mixed cropping or mono-cropping. Further, activities in the food crop sub-sector have contained to dominate the category farms variously referred to as small-holder farms, small-scale farm, low-resource farms or small farms (Olayemi, 1980).

This category of farms represent as much as 95% the total food-crop farming units in the country and produces about 90% of the total food-crop output (Okuneye and Okuneye, 1988). These farms are characterized by low level of operation, illiteracy of operation and a labour intensive production technology with hired labour cost constituting about 60% of the total cash cost of production (Olayemi, 1980; Aromolaran, 1992). In small-scale agriculture, the farming system is embedded in the household economy, which integrates both production and consumption and it shaped by the multiple goals that are operative in the system (Norman *et al*., 1982).

In Nigeria, food production has not increased at the rate that can meet the increasing population. Food production increases at the rate of 2.5%, while the demand for food increases at a rate >3.5% due to the high rate of population growth of 2.83%. The apparent disparity between the rate of food production and it demand has led to a food demand supply gap and there's an increasing resort to food importation.

The labour force during those times is of household consisting of men, women and children, as a result of this, rural smallholder agriculture remained the major power for rural growth and livelihood improvement. The rural population provides about 90.0% of the food produced in

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Nigeria, while the remaining 10.0% is assumed to be obtained through importation which means Nigeria is yet to be self-sufficient in food production (Okuneye and Okuneye, 1988).

The pivotal role of the efficiency in accelerating agricultural productivity and output has been applauded and investigated by numerous researchers and policy makers within Africa and outside alike. An underlying premise behind much of the research on efficiency is that if farmers are not making efficient use of existing technology, then efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 1985; Shapiro, 1983; Bravo-Ureta and Pinheiro, 1994).

However, the aim of every farmer is to make profit whether much or litter here, profit efficiency can be defined as the ability of a firm or farm to achieve potential maximum profit, given a level of fixed factors and prices faced by the firm (Adesina and Diato, 1996).

The broad objective of this study is to analyze profit efficiency among smallholder farmers in Atiba Local Government Area of Oyo State.

The specific objectives are to:

- Examine the input used by the smallholder farmers.
- Examine the profit efficiency of smallholder farmers.

Hypothesis of the study is stated in the null form as: Smallholder farmers are not profit efficient.

It is evident that:

- The study of profit efficiency among smallholder farmers will in empirical term reveal the constraints and conditions confronting the male and female smallholder farmer's productivity and as well as efficiency of resource combination and usage.
- It will serve as the foundation for predicting the consequences of fluctuations in the economic conditions of producing various food crops and in turn reflect in the aggregate output of food crops available for human consumption.

The outcome of the study, allows us know the profit efficiency level among the smallholder farmers. It shows the influence of socio-economic characteristics of the respondents. It helps to estimate the profit level among the smallholder farmers and also the constraints to profit efficiency among the smallholder farmers.

Literature review

Normalized profit function: The actual normalized profit function which was assumed to be well-behaved can be expressed as:

$$\Pi (P_1 Z) = Y (X^*, Z) - \Sigma P_1 X_1^*$$
$$X^* = g (P_1 Z) \quad (1)$$

where, * means the profit function is non-increasing in input prices and non-decreasing in output prices, homogenous of degree zero in input and output prices and convex in input and output prices.

Where, Y (X*, Z) is the production function, the asterisk denotes optimized values; P_i= w/p, where, p and w are the output and input prices, respectively and p_1 is the normalized price of input.

The stochastic profit function can then be expressed as:

$$\Pi_j = f (P_{ij}) = \exp e_j \quad (2)$$

where,

Π_j = Normalized profit of the jth farm, computed as gross revenue less variable cost, divided by farm specific output price p.

P_{ij} = The normalized price of input I for the jth farm, calculated as input price divided by farm specific output price p_j, z_{kj} is the level of the kth fixed factor for the jth farm.

e_j = An error terms. The error term e_j is assumed to behave in a manner consistent with the frontier concept.

$$e_j = V_j + U_j \quad (3)$$

where,

V_j = The symmetric error term.

U_j = A one sided error term.

V_j's = Assumed to be independently and identically distributed (i.i.δ) as N (O, δ^2v).

We assumed that V_j has a half-normal non-negative distribution, N (O, δ^2u) U and n are also assumed to be independent of each other. U_j is used to represent inefficiency that is, it represents profits short fall from its maximum possible value given by stochastic frontier. Thus, if U_j = O, the firm lies on the profit frontier, obtaining potential maximum profit given the prices it faces and the levels of fixed factors. If U_j>0, the firm is inefficient and loses profit as a result of inefficiency.

An average frontier model result of the frontier model is estimated without the one-side disturbance term, U_j. This approach has been criticized. On the other hand, a full deterministic or full frontier model, often estimated by linear programming techniques, results if the random error term V_j is omitted. If Eq. (2) is estimated econometrically rather than a model consisting of Eq. (2) and (3), an average as opposed to the frontier is obtained. It is therefore, essential to estimate the frontier function to provide and estimate of industry best practice profit for any given level of prices and fixed factors.

Given the specification of U, the population mean and variance of U:

$$E(u) = du\sqrt{(2/\psi)} \quad (4)$$

$$V(u) = \delta^2 u(\Psi-2)/\Psi \quad (5)$$

where, Ψ is a constant equal to 3.14 the expected inefficiency in the population is then given as:

$$E(e^{-u}) = 2\frac{e\delta^2 u}{2}[1-F(\delta u)] \quad (6)$$

where, F is the standard normal distribution function.

The farm-specific representation of conditional inefficiency (U_j/e_j) for each observation is derived from the conditional distribution of U_j, where, $U_j = e_j + V_j$ and it has an expectation of:

$$E(U_j/e_j) = \frac{\delta u\,\delta v}{\delta}\,\frac{F(e_{j\lambda}/\delta)-e_{j\lambda}}{1-F(e_{j\lambda}/\delta)} \quad (7)$$

where, $\lambda = \delta u/\delta v$, $\delta^2 = \delta^2 + \delta^2$ and f and d f are the standard normal density and cumulative distribution functions, respectively, evaluated at $e_{j\lambda}/\delta$. The farm-specific Profit Efficiency Index (PIE) derived using the results from Eq. (7) as given as:

$$PIE = [1-\exp(U_j)]$$

Profit loss due to inefficiency is represented as potential maximum profit given farm specific prices and fixed factors, multiplied by farm-specific profit inefficiency index. The 2nd objective of the study is achieved by relating the profit inefficiency index to farm and household attributes. This can be specified as:

$$PIE = g(X),$$

where,

PIE = The profit inefficiency index.

X = A vector of farm household attributes.

The profit inefficiency index is therefore, hypothesized to be related to attributes of the farm household.

MATERIALS AND METHODS

The study area: The study was carried out in Atiba Local Government Area of Oyo State in the south-west zone of Nigeria. The local government has about 153 villages most of which are predominantly rural with special interest in agriculture. The main occupation in this local government is farming due to favorable climatic condition.

The study area is situated with the tropical rainforest region and the existence of a large number of smallholder farmers in the area, thus allowed for a reasonable selection of the representative sample of smallholder farmers. The climate in the study area is of tropical type with two distinct rainfall patterns. The rainy season which marks the agricultural production season is normally between the months of April and October. The heaviest rainfall is recorded between the months of June and August while the driest months are November to March. Agriculture is the main occupation of the people and small-scale traditional farming system predominate the area. The major food crops grown in the states include maize, yam, cassava, rice, cocoyam while the major cash crops grown are cocoa, kola nut and oil palm.

Sampling procedure and sample size: The study used a multi-stage stratified random sampling technique. The first stage involved purposive selection of Atiba Local Government Area of Oyo State. The 2nd stage involved random selection of major villages from the list of villages obtained from the information units of the Local Government Area. A total of 6 villages were sampled and these include: Baale Agba, Oja Kesan, Oja-Koso, Eleke, Ajiroba and Efunlete. The last stage involved a random selection of 20 smallholder farmers from the 6 selected villages in the Local Government area. A total of 120 smallholder farmers were interviewed with the aid of a structured questionnaire.

Method of data collection: The primary data was mainly used. The primary data was collected with the used of structured questionnaires. Input-Output data were collected. Output data include quantity and values of output, market prices, while input data include quantity and cost of inputs such as farm size, hired labour, family labour, fertilizer, seeds, cutting, sets, pesticides, herbicides and amount on farm implements. The data obtained pertained to 2007 planting season and were obtained between the months of Aprils and June, 2007.

Method of data analysis: The analytical techniques that were used in this analysis, include stochastic frontier profit function.

$$\ln\Pi = \alpha + \sum_{j=1}^{4}\alpha_j \ln p_j + \tfrac{1}{2}\sum_{j=1}^{5}\sum_{j=1}^{5}\alpha_{jk}\ln p_j \ln p_k + \sum_{j=1}^{5}\sum_{l=1}^{m}\alpha_{jl}$$

$$\ln p_j \ln Z + \Sigma ß_1 \ln z_i + \tfrac{1}{2}\Sigma\Sigma ß_u \ln Z_i + e_1$$

The general form of the translog profit frontier is defined as:

where,

P : Restricted profit (total revenue less total cost of variable inputs normalized by price of output (P_y).
j = 1 : Labour wage.
j = 2 : Material input price.
j = 3 : Fertilizer.
j = 4 : Agro chemical price.
Z_i : Equipment cost.
Σ_j : Error term.

where, $\varepsilon_j = V-U$

The profit efficiency of the jth farm is given by exp ($-U_j$), or profit inefficiency by [1-exp ($-U_j$)]. Profit loss due to inefficiency was then calculated as maximum profit at farm-specified prices and fixed factors multiplied by farm specific profit inefficiency = max profit (1-PE) where, $P\Sigma$ = profit efficiency.

The 5th objective of the study was to identify factors associated with profit loss. This was achieved by estimating the Ordinary Least Squares (OLS) multiple regression model.

$$PL = F(Z_1, Z_2, Z_3, Z_4, Z_5, e)$$

where,

PL = Profit loss.
Z_1 = Years of schooling.
Z_2 = Years of farming experience.
Z_3 = Farm size (Ha).
Z_4 = Labour (Mandays).
Z_5 = Family size.
e = Error term.

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

Measurement of variables: There are 2 types of variables in this study, the dependent and independent variables. The dependent variable is the profit measured in naira while, the independent variables includes labour measured in Naira and mandays, material input measured in Naira. Fertilizer measure in Naira and Kg, Agrochemical measured in Naira and litres and Equipment cost measured in Naira.

RESULTS AND DISCUSSION

Profit efficiency estimation

Maximum likelihood estimate of profit frontier function: T he MLE estimates of Eq. 1 are presented in Table 1. The result of the analysis reveals that labour has a positive and significant relationship with profit in male and pooled data while, it is insignificant in female respondents. This indicates that, labour is an imported factor explaining changes in profit. The coefficient of materials inputs was found to be significant and negative among the smallholder farmers. This implies that material input is a negative factor that influences profit in the study area. Hence, the more the cost of material inputs, the less the profit. Moreover it was also observed that, the coefficient of fertilize have an insignificant and negative relationship among the smallholder farmers. This indicates that as the cost of fertilizer increases, profit decreases. Agrochemical was found to be significant in the study area. Equipment has a significant but negative relationship among the smallholder farmers. This implies that equipment is negative factor that influences profit in the study area.

Table 1: Maximum likelihood estimates of profit frontier function in atiba local government area

Variables	Pooled
Constant	9.737 (8.965)*
Ln P_1	1.396 (2.762)*
Ln P_2	-1.541 (-2.162)*
Ln P_3	-0.299 (-0.406)
Ln P_4	2.616 (3.326)*
Ln Z_1	-3.125 (-3.715)*
½ Ln P_1^2	-0.115 (-2.788)*
½ Ln P_2^2	0.126 (2.270)*
½ Ln P_3^2	0.0115 (0.081)
½ Ln P_4^2	-0.101 (-1.618)
½ Ln Z_1^2	0.387 (2.416)*
Ln P_1 Ln P_2	0.066 (1.586)
Ln P_1 Ln P_3	-0.173 (-4.214)*
Ln P_1 Ln P_4	-0.099 (-1.752)*
Ln P_1 Ln Z_1	0.029 (0.569)
Ln P_2 Ln P_3	0.055 (0.849)
Ln P_2 Ln P_4	0.029 (0.864)
Ln P_2 Ln Z	0.019 (0.210)
Ln P_3 Ln P_4	-0.198 (-2.299)*
Ln P_3 Ln Z	0.363 (3.108)*
Ln P_4 Ln Z	-0.121 (-1.811)*
δ^2	7.168 (6.575)*
γ	0.999(660.080)*
Log likelihood function	-150.511

-Figure in parentheses are the t-value; * Estimates are significant

The estimated sigma-squared (δ^2) is significantly different from 0 at the 1% level. This indicates a good fit and correctness of the specified distributional assumptions of the composite error term. The observed significance of δ^2 conforms to Rahman (2003), Hjalmarsson *et al.* (1996) and Sharma *et al.* (1991). 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 0.999 among the smallholder farmers. This means that 99.9% of the total variation in crop production is due to profit inefficiency in male, female and pooled data, respectively.

Table 2: Frequency distribution of profit efficiency for smallholder farmers in atiba local government area

Profit efficiency	Pooled
<0.5	77 (64.2)
0.5-0.59	07 (5.8)
0.6-0.69	08 (6.7)
0.7-0.79	05 (4.2)
0.8-0.89	11 (9.2)
0.9-0.99	12 (10)
Total	120
Mean	0.422
Minimum	0.000586
Maximum	0.999

Figure in parentheses are the percentages

Table 3: Determinants of profit loss by smallholder farmers in atiba local government area

Variables	Pooled
Constant	3348.301 (0.101)
Education	-1136.382 (-0.328)
Experience	-2874.830 (-3.357)*
Farm size	16870.872 (5.118)*
Hired labour	0.00994 (0.107)
Family size	6559.376 (2.111)*
R_2	0.315
F-value	9.933*

Figure in parentheses are the t-value

Frequency distribution of profit efficiency: The distribution of profit efficiency of smallholder farmers is presented in Table 2. Among the smallholder farmers, the profit efficiency ranged between 0.000586 and 0.999 with an average of 0.422. This implies that the average farmer in the study area could increase profit by 57.8% by improving their technical and allocative efficiency.

The smallholder farmers in the study area exhibit a wide range of profit inefficiency ranging from 1-99.9%. Observation of wide variation in profit efficiency is not surprising and similar to the results from other studies. For example, Ali and Flinn (1989) reported mean profit efficiency level of 0.69 (range 13-95%) for Basmati rice producers of Paskistan Punjab. Ali *et al*. (1994) reported mean profit efficiency level of 0.75 (range 4-90%) for rice producers in North west frontier province of Pakistan. 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 range for Bangladash rice farmers. The Table 3 also shows that majority of the respondents have profit efficiency <0.5, while few of them had profit efficiency between 0.9 and 0.99.

Determinants of profit loss: The OLS estimates of the relationship between loss of profit and farm household characteristics showed that the farmers with better experience exhibited significantly less loss of profit than those with little experience. Large farms did not exhibit a significantly higher profit loss than smaller farms among the farmers. This finding is consistent with those of Saleem (1978), Ohajianya (2005) and Bravo-Ureta and Pinheiro (1994). Farmers with more family size exhibited significantly less loss of profit than farmers with less family size among the smallholder farmers (Table 3).

CONCLUSION

The objective of the study was to analyze the profit efficiency among small holder farmers in Atiba Local Government Area of Oyo State. The maximum likelihood estimate of the profit frontier function reveals that labour has a positive and significant relationship with profit in male and pooled data, while it is insignificant in female respondents which indicate that labour is an imported factor explaining changes in profit. Also, equipment has a significant but negative relationship with profit among the farmers. This implies that equipment is negative factor that influences profit in the study area.

The profit efficiency ranged between the profit efficiency ranged between 0.000586 and 0.999 with an average of 0.422. This implies that the average farmer in the study area could increase profit by 57.8% by improving their technical and allocative efficiency.

The study shows that small-scale farming is profitable in the study area and the result also shows that resources were utilized effectively. The acceleration of the economic development with respect to agricultural development, there is need to put in place appropriate policies as well as focus on food crop production by smallholder farmers.

RECOMMENDATIONS

Based on the results and various observations from findings, the following recommendations were made:

- Agricultural inputs, improved seed varieties should be made available to small holder farmers in order to improve production.
- Bodies that could loan out money should be set up by the government apart from cooperatives.
- Education and skill acquisition programmes should be organized for the smallholder farmers in the study area to enable them maximize the use of the available technology thereby improving their productivity.
- Female farmers should be encouraged by eliminating any barrier that can engender inequalities in their access to the productive resources of the farm.

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