# Economic Efficiency of Small-Holder Cocoyam Farmers in Anambra State, Nigeria: A Translog Stochastic Frontier Cost Function Approach

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# ECONOMIC EFFICIENCY OF SMALL-HOLDER COCOYAM FARMERS IN ANAMBRA STATE, NIGERIA: A TRANSLOG STOCHASTIC FRONTIER COST FUNCTION APPROACH

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## ABSTRACT

This study employed a translog stochastic frontier cost function to measure the level of economic efficiency and it's determinants in small-holder cocoyam production in Anambra state, Nigeria. A multi-stage random sampling technique was used to select 120 cocoyam farmers in the state in 2005 from whom input-output data and their prices were obtained using the cost-route approach. The parameters of the stochastic frontier cost function were estimated using the maximum likelihood method. The results of the analysis show that individual farm level technical efficiency was about 59%. The study found age, education and farm size, to be negatively and highly significantly related to economic efficiency at 1.0% while fertilizer use and farmer experience were significant and directly related to economic efficiency at 1.0% and 5.0% levels of probability respectively. No significant relationship was found between economic efficiency and extension visit, family size, credit access and membership of cooperative societies.

**Key words:** Translog Stochastic Frontier Cost Function and Economic Efficiency.

## INTRODUCTION

Cocoyam ranks third in importance and extent of production after yam and cassava among the root and tuber crops of economic value in Nigeria (Udealor, *et al*., 1996). Edible cocoyam cultivated in the country is essentially species of *Colocasia* (taro) (Howeler *et al*., 1992) and *Xanthosoma* (tannia). Currently Nigeria is the world's largest producer of cocoyam in the world. The average production figure for Nigeria is 5, 068,000mt which accounts for about 37% of total world output of cocoyam (FAO, 2006). It is an important staple food crop commonly grown by women in Nigeria.

Cocoyams are an important carbohydrate staple food particularly in the Southern and Middle belt areas of the country (Asumugha and Mbanaso, 2002). Nutritionally cocoyam is superior to cassava and yam in the possession of higher protein, mineral and vitamin contents in addition to having a more digestible starch (Parkinson, 1984, Splitstoesser *et al.*, 1973).

Production of cocoyam has not been given priority attention in many countries probably because of its inability to earn foreign exchange and its unacceptability by the high income countries for both consumption and other purposes (Onyenweaku and Ezeh, 1987). Most of what is produced is consumed locally (Mbanaso and Enyinnaya, 1989). The production is labour intensive with most operations carried out manually at the traditional level.

Farm efficiency, and the question of how to measure it, is an important subject in developing countries' agriculture (Shah, M. K, 1995; Hazarika and Subramanian, 1999). There are four major approaches to measure efficiency (Coelli *et al*., 1998). These are the non-parametric programming approach (Charnes *et al*., 1978), the parametric programming approach (Aigner and Chu, 1968; Ali and Chaudry, 1990), the deterministic statistical approach (Afriat, 1972; Schippers, 2000; Fleming *et al*, 2004)] and the stochastic frontier approach (Aigner *et al.,* 1977; Kirkley *et al*., 1995). Among these, the stochastic frontier and non-parametric programming, known as data envelopment analysis (DEA), are the most popular approaches. The stochastic frontier approach is preferred for assessing efficiency in agriculture because of the inherent stochasticity involved (Ezeh, 2004 and Coelli, 1994).

The objective of this study is therefore to measure the level of economic efficiency and its determinants in cocoyam production in Anambra State, Nigeria using the stochastic frontier translog cost function approach. The cost function approach combines the concepts of technical and allocative efficiency in the cost relationship. Technical and allocative efficiencies are necessary, and when they occur together, are sufficient conditions for achieving economic efficiency (Yotopoulous and Lau, 1973). Economic efficiency is the ability of farms to maximize profit. (Adeniji, 1988; Ohajianya and Onyenweaku, 2001). It is also described as the product of technical and allocative efficiency (Adeniyi, 1988). It indicates the costs per unit of output for a firm which perfectly attains both technical and price efficiencies.

## METHODOLOGY

**(a) The Theoretical Model:** The stochastic frontier cost function is defined by:

$$C = F(Wi, Yi; \alpha) \exp v_i - u_i \qquad i = 1,2 \ldots n \quad \text{------------------------------------------} \quad (1)$$

Where,

C = Represents the minimum cost associated with cocoyam production

W= Vector of input prices

Y = Cocoyam output

$\alpha$ = Vector of parameters

$\varepsilon_i$ = Composite error term ($v_i - u_i$)

Using Sheppard's Lemma we obtain

$$\frac{\partial C}{\partial P_i} = X_i (W, Y; \alpha) \quad \text{------------------------------------------------} \quad (2)$$

This is a system of minimum cost input demand equations (Bravo – Ureta and Evenson, 1994; Xu and Jeffrey, 1995 and Bravo- Ureta and Pinheiro, 1997). Substituting a farm's input prices and quantity of output in equation (2) yields the economically efficient input vector $X_{c..}$ With observed levels of output given, the corresponding technically and economically efficient costs of production will be equal to $X_{ii}$ P and $X_{ie}$, respectively. While the actual operating input combination of the farm is $X_i$ P. The cost measures can then be used to compute the economic efficiency indices as follows;

$$EE = (X_{ie}.P) / (X_i.P) \quad \text{---------------------------------------------}(3)$$

However the efficient production is represented by an index value of 1.0 while the lower values indicate a greater degree of inefficiency. Using the method by Bravo-Ureta and Pinheiro (1997) which was based on the work of Jondrow *et al* (1982), u can be estimated as

$$E(u_i / \varepsilon_i) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{f^*(\varepsilon_i \lambda / \sigma)}{1 - F^*(\varepsilon_i \lambda)} - \Sigma i\lambda\right] \quad \text{------------------------------------------} \quad (4)$$

Where

$f^*(.)$ and $F^*(.)$ are normal density and cumulative distribution functions respectively,

$\lambda = \sigma_u / \sigma_v$

$\varepsilon = v_i - u_i$ and

When $\varepsilon i$, $\sigma$ and $\lambda$ estimates, are replaced in equation (4), it will provide estimates for *u* and *v*. The term V is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g. weather, disease outbreaks, measurements errors, etc. The term *u* is a non negative random variables representing inefficiency in production relative to the stochastic frontier. The random error $v_i$ is assumed to be independently and identically distributed as $N(o, \sigma_v^2)$ random variables independent of the $u_i$s which are assumed to be non negative truncation of the $N(o,\sigma_u^2)$ distribution (i.e. half-normal distribution) or have exponential distribution.

**(b) The Empirical Model:** In this study, the stochastic frontier translog cost function was estimated for cocoyam using the Maximum Likelihood method. The model is specified as follows:

$$\begin{aligned}\text{Ln } C_i &= \alpha_0 + \alpha_1 \text{Ln } W_1 + \alpha_2 \text{Ln } W_2 + \alpha_3 \text{Ln } W_3 + \alpha_4 \text{Ln } W_4 + \alpha_5 \text{Ln } W_5 + \alpha_6 \text{Ln } W_6 + \alpha_7 \text{In } Y_7 + 0.5\alpha_8 \text{In } W_1^2 + 0.5\alpha_9 \text{In } W_2^2 + 0.5\alpha_{10} \text{In } W_3^2 + 0.5\alpha_{11} \text{In } W_4^2 + 0.5\alpha_{12} \text{Ln } W_5^2 \\ &+ 0.5\alpha_{13} \text{Ln } W_6^2 + 0.5\alpha_{14} \text{Ln } Y_7^2 + \alpha_{15} \text{Ln } W_1 \text{In } W_2 + \alpha_{16} \text{Ln } W_1 \text{Ln } W_3 + \alpha_{17} \text{In } W_1 \text{Ln } W_4 + \alpha_{18} \text{Ln } W_1 \text{Ln } W_5 + \alpha_{19} \text{Ln } W_1 \text{In } W_6 + \alpha_{20} \text{Ln } W_1 \text{Ln } Y_7 + \alpha_{21} \text{Ln } W_2 \text{Ln } W_3 \\ &+ \alpha_{22} \text{Ln } W_2 \text{Ln } W_4 + \alpha_{23} \text{Ln } W_2 \text{Ln } W_5 + \alpha_{24} \text{Ln } W_2 \text{Ln } W_6 + \alpha_{25} \text{Ln } W_2 \text{Ln } Y_7 + \alpha_{26} \text{Ln } W_3 \text{Ln } W_4 + \alpha_{27} \text{Ln } W_3 \text{Ln } W_5 + \alpha_{28} \text{Ln } W_3 \text{Ln } W_6 + \alpha_{29} \text{Ln } W_3 \text{Ln } Y_7 + \alpha_{30} \text{Ln } W_4 \text{Ln } W_5 \\ &+ \alpha_{31} \text{Ln } W_4 \text{Ln } W_6 + \alpha_{32} \text{Ln } W_4 \text{Ln } Y_7 + \alpha_{33} \text{Ln }_5 W \text{ Ln } W_6 + \alpha_{34} \text{Ln }_5 W \text{ Ln } W_6 + \alpha_{35} \text{Ln}_5 W \text{Ln} Y_7 + V_i - U_i \quad \text{-----------} \quad (6)\end{aligned}$$

Where $\text{Ln}C_i$ represents total input cost of the i-th farm, $W_1$ is average daily wage rate per manday, $W_2$ is price of fertilizer per kg, $W_3$ is land rent in naira per hectare, $W_4$ is price of planting materials in naira per kg, $W_5$ is price of other inputs in naira. $W_6$ is capital input in naira made up of depreciation charges on farm tools and equipment, interest on borrowed capital and rent on land, Y is output of cocoyam in kg adjusted for statistical noise, $\alpha_0$ $\alpha_1$ $\alpha_2$ ….. $\alpha_{27}$ are regression parameters to be estimated while $u_i$ and $v_i$ are as defined earlier.

**(c) Determinants of Economic Efficiency:** The determinants of economic efficiency were modeled in terms of socio-economic variables of the farmers and other factors. The economic efficiency in the model was simultaneously estimated with their determinants Exp (-Ui), defined by.

$$\text{Exp.}(-Ui) = ao + a_1Z_1 + a_2Z_2 + a_3Z_3 + a_4Z_4 + a_5Z_5 + a_6Z_6 + a_7Z_7 + a_8Z_8 + a_9Z_9 \quad \ldots\ldots \; (7)$$

Where Exp. (-Ui), is the economic efficiency of the i-th farmer, $Z_1$ is farmers age in years, $Z_2$ is farmers level of education in years, $Z_3$ is the number of extension contacts made by the farmer in the year, $Z_4$ is household size, $Z_5$ is farm size in hectares , $Z_6$ is farmer's farming experience in years, $Z_7$ is fertilizer use, a dummy variable which takes the value of unity for fertilizer use and zero otherwise, $Z_8$ is credit access, a dummy variable which takes the value of unity if the farmer has access to credit and zero otherwise, $Z_9$ is membership of farmers associations/cooperative societies, a dummy variable which takes the value of unity for members and zero otherwise while $a_0,a_1,a_2\ldots a_9$ are regression parameters to be estimated. We expect $a_2$, $a_3$, $a_5$, $a_6$, $a_7$, $a_8$ and $a_9$ to be positive and $a_1$ and $a_4$ negative.

**(d) The Data:** Anambra State is located in the South Eastern region of Nigeria between longitude $6^0$ 36`E to $7^0$ 21` and latitude $5^0$38`N to $6^0$ 47`N. The State is bounded in the North by Kogi State, in the west by River Niger and Delta State, in the south by Imo State and on the east by Enugu State. It has twenty one (21) Local Government Areas with Awka as the State Capital. It was created in 1991 with a population figure of 2.767 million people (NPC, 1991) and a land mass of 4415.54 square kilometres, 70% of which is rich for agricultural production (Nkematu, 2000). The State for administrative purposes is divided into four agricultural zones of Aguata, Anambra, Awka and Onitsha. The zones are further delineated into 24 extension blocks and 120 circles. Farming is the predominant occupation of the people, majority of who are small holders. The major available crops are yam, cassava, rice, maize, cocoyam, cowpea, tomatoes and vegetables, while the livestock produced in the state include poultry, sheep, goats and to some extent pig.

Three out of the four agricultural zones were purposively selected on the basis of the intensity of cocoyam production. They are Aguata, Awka and Onitsha. Two extension blocks were randomly selected from each agricultural zone (Aguata and Nnewi North from Aguata zone, Awka North and Anaocha from Awka zone as well as Idemili North and Ihiala from Onitsha zone) and 2 circles from each block. Finally 10 farmers were randomly selected from each circle for detailed study, giving a total sample size of 120 farmers in the state. Data were collected by means of structured questionnaire on the socio-economic characteristics of the farmers, and their production activities in terms of inputs, output, and their prices for the year 2005 using the cost-route approach.

## RESULTS AND DISCUSSION

### (a) Socio-Economic Characteristics

Table 1 shows the frequency distribution of respondents according to sex, age, education, farming experience, farm size and house hold size. Seventy four percent (74%) of the respondents were females while 31% were males. This implies that women constitute a greater percentage of those involved in cocoyam production in Anambra State. More than 50 percent of the farmers comprise those that have attained the age of fifty years and above. Cocoyam production is less laborious than other root and tuber crops and does not require a lot of physical strength. About 45 percent of the farmers had no formal education, while only 17.5% attended primary school. Educated farmers are expected to be more receptive to improved farming techniques (Okoye *et al*, 2004).

About 12.5% of the respondents had less than 5 years of farming experience while 87.5% had more than 5 years of farming experience. The mean farming experience was 13 years, farmers are therefore described as experienced and are expected to have higher efficiency. Nwaru (1993) reported that farmers count more on their experience than educational attainment in order to increase their productivity.

**Table 1: Distribution of Cocoyam Farmers According to their Sex, Age, Education, Farming experience, Farm size and Household size**

| Variable | Frequency | Percentage (%) |
|---|---|---|
| **Sex** | | |
| Male | 31 | 25.83 |
| Female | 89 | 74.20 |
| Total | 120 | 100 |
| **Age (in years)** | | |
| 24-29 | 5 | 4.16 |
| 30-35 | 6 | 5.00 |
| 36-40 | 11 | 9.17 |
| 41-45 | 14 | 11.17 |
| 46-50 | 17 | 14.17 |
| >50 | 67 | 55.83 |
| Total | 120 | 100 |
| Mean | 50(yrs) | |
| **Educational level** | | |
| No Schooling | 54 | 45.00 |
| Primary | 21 | 17.50 |
| Secondary | 31 | 25.83 |
| Tertiary | 14 | 11.70 |
| Total | 120 | 100 |
| Mean | 6.3(yrs) | |
| **Farming Experience (yrs)** | | |
| < 5 | 15 | 12.5 |
| 5-10 | 48 | 40 |
| 11-16 | 17 | 14.17 |
| 17-22 | 20 | 16.6 |
| >22 | 20 | 16.6 |
| Total | 120 | 100 |
| Mean | 13.35 (yrs) | |
| **Farm size(ha)** | | |
| 0.01 – 0.05 | 54 | 45.00 |
| 0.06-0.10 | 3 | 2.50 |
| 0.20-0.60 | 52 | 43.20 |
| 0.70-1.00 | 9 | 7.50 |
| 1ha and above | 2 | 1.70 |
| Total | 120 | 100 |
| Mean | 0.27(ha) | |
| **Household Size** | | |
| 2-4 | 2 | 1.67 |
| 5-7 | 23 | 19.17 |
| 8-10 | 7 | 5.83 |
| 11-13 | 16 | 13.33 |
| >13 | 72 | 60.00 |
| Total | 120 | 100 |
| Mean | 12(persons) | |

**Source: Field Survey, 2005**

Forty eight percent (48%) of the respondents have cocoyam holdings of less than 0.1ha. This implies that cocoyam production in the study area is dominated by small-scale producers given the average farm size of 0.27ha for the area. The data on Table 1. also depicts that a large percentage (98%) of the respondents have household sizes of 5 persons and above while less than 2% have household size of less than 5 persons. Effiong (2005) and Idiong (2005) reported that a relatively large household size enhances the availability of labour though large household sizes may not guarantee increased efficiency since family labour which comprises mostly children of school age are always in school.

**(b) Estimation of Economic Efficiency**

Table 2. shows the maximum likelihood estimates of the cost frontier for cocoyam production in Anambra State. The sigma ($\sigma^2 = 0.53$) and the gamma ($\gamma$=0.98) are quite high and highly significant at 1.0% level of probability. The high and significant value of the sigma square ($\sigma^2$) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma$ = 0.99) shows that 99% of the variability in the output of cocoyam farmers that are unexplained by the function is due to economic inefficiency.

The first order explanatory variables showed that the coefficient of the variables (wage rate, price of fertilizer, land rent, price of setts, price of manure and output) all have the desired positive signs which agree with a priori expectations. Wage rate, land rent and price of setts were highly significant at 1.0% level of probability. This implies that increasing the prices of land, wage rate and setts by 1.0% would increase total cost of production by 4.33, 4.64 and, 4.87 respectively. The high value of these coefficients indicates the importance of these variables in the cost structure of the farmers.

Most of the interaction terms (second order coefficients) were statistically significant at the conventional significance levels, implying the suitability of the translog function. Among the second order terms, the coefficients of the square term for wage rate, and those of the interactions of wage rate/depreciation, price of fertilizer/price of setts are positive and highly significant at 1.0% level of probability showing a direct relationship with total cost. The coefficients for the interaction terms for price of fertilizer/depreciation, land rent/price of setts, wage rate/land rent ad price of other inputs/depreciation were negative and highly significant at 1.0% level of probability indicating an indirect relationship with total cost. The coefficient for the interaction term for price of fertilizer/land rent was negative and statistically significant at 5.0% level of probability. The coefficients of the square term for price of setts, and those of the interactions of wage rate/land rent, price of fertilizer/price of other inputs, and price of fertilizer/depreciation had an indirect relationship with total cost and statistically significant at 10.0% level of probability.

**Table 2: Maximum likelihood Estimates of the Stochastic Cost Function (Translog) for Cocoyam Production.**

| Production Factors | Parameter | Coefficient | Standard Error | t-value |
|---|---|---|---|---|
| Constant Term | $w_o$ | 150.4583 | 1.0100 | 148.957*** |
| Wage rate | $w_1$ | 4.6431 | 0.1050 | 4.4419*** |
| Price of fertilizer | $w_2$ | 0.3561 | 0.7651 | 0.4654 |
| Land rent | $w_3$ | 4.3376 | 0.7644 | 5.6747*** |
| Price of setts | $w_4$ | 4.8785. | 1.2181 | 4.0048*** |
| Price of other inputs | $w_5$ | 0.1613 | 0.9443 | 0.1708 |
| Depreciation on tools | $w_6$ | -1.7787 | 0.7978 | 9.7607*** |
| Output (Y*) | $w_7$ | 0.0583 | 0.8363 | 0.0694 |
| Wage rate$^2$ | $w_8$ | 1.7252 | 0.2538 | 28.5622*** |
| Price of fertilizer$^2$ | $w_9$ | -0.1040 | 0.4608 | -0.2256 |
| Land rent$^2$ | $w_{10}$ | -0.0765 | 0.0915 | -0.8366 |
| Price of setts$^2$ | $w_{11}$ | -0.5245 | 0.2892 | -1.8137* |
| Price of other inputs$^2$ | $w_{12}$ | 0.0633 | 0.1264 | 0.5010 |
| Depreciation$^2$ | $w_{13}$ | 0.0630 | 0.0999 | -0.6309 |
| Output(Y*) | $w_{14}$ | -0.0886 | 0.1301 | -0.6813 |
| Wage rate x Price of fertilizer | $w_{15}$ | 0.0008 | 0.0005 | 0.1519 |
| Wage rate x land rent | $w_{16}$ | -0.5038 | 0.2668 | -1.8880* |
| Wage rate x Price of other inputs | $w_{17}$ | 0.0753 | 0.2042 | 0.3688 |
| Wage rate x Depreciation | $w_{18}$ | 1.2503 | 0.1607 | 7.7783*** |
| Wage rate x Output (Y*) | $w_{19}$ | 0.0003 | 0.0003 | 0.0001 |
| Price of fertilizer x land rent | $w_{20}$ | -0.0764 | 0.0374 | -2.0390** |
| Price of fertilizer x Price of setts | $w_{21}$ | 0.1845 | 0.0528 | 3.4927*** |
| Price of fertilizer x Price of other inputs | $w_{22}$ | -0.0725 | 0.0429 | -1.6868* |
| Price of fertilizer x Depreciation | $w_{23}$ | 0.0767 | 0.0394 | 1.9442* |
| Price of fertilizer x Output (Y*) | $w_{24}$ | -0.0661 | 0.0154 | -4.2783*** |
| Land rent x Price of setts | $w_{25}$ | -0.2516 | 0.0942 | -2.6702*** |
| Land rent x Price of other inputs | $w_{26}$ | 0.1068 | 0.0713 | 1.4973 |
| Land rent x Depreciation | $w_{27}$ | 0.0074 | 0.0915 | 0.0807 |
| Land rent x Output (Y*) | $w_{28}$ | 0.0399 | 0.0540 | 0.7390 |
| Wage rate x land rent | $w_{29}$ | -0.4821 | 0.1334 | -3.6126*** |
| Price of setts x Price of other inputs | $w_{30}$ | 0.1039 | 0.1566 | 0.6555 |
| Price of setts x Depreciation | $w_{31}$ | 0.0751 | 0.1261 | 0.5959 |
| Price of setts x Output (Y*) | $w_{32}$ | -0.0156 | 0.1116 | -0.1398 |
| Price of other inputs x Depreciation | $w_{33}$ | -0.3009 | 0.0638 | -4.7108*** |
| Price of other inputs x output(Y*) | $w_{34}$ | 0.0242 | 0.0385 | 0.6272 |
| Depreciation x output (Y*) | $w_{35}$ | 0.0787 | 0.0668 | 1.1810 |
| **Diagnostic statistics** | | | | |
| Log – likelihood function | | -38.608 | | |
| Total Variance | ($\sigma$ ) | 0.5382 | 0.1032 | 5.2142*** |
| Variance Ratio | ($\gamma$) | 0.9975 | 0.0017 | 587.066*** |
| LR Test | | 102.66 | | |

**Source:** Computed from frontier 4.1 MLE/Survey data, 2005

The results of the frequency distribution of economic efficiency estimates are shown in table 3. The economic efficiency estimates presented in Table 3. indicates that it ranged from 0.10 to 0.98 ; the mean economic efficiency was 0.59. The estimates show that for the average cocoyam farmer to attain the level of the most economical efficient farmer in the sample, he or she would experience a cost savings of 39.70 (1 – 059/0.98) per cent.

**Table 3: Frequency Distribution of Economic Efficiency Indices.**

| Economic Efficiency Index | Frequency | Percentage |
|---|---|---|
| < 0.50 | 45 | 37.50 |
| 0.51 – 0.60 | 11 | 9.16 |
| 0.61 - 0.70 | 4 | 3.33 |
| 0.71 – 0.80 | 18 | 15.00 |
| 0.81 – 0.90 | 8 | 7.50 |
| 0.91 - 1.00 | 33 | 27.50 |
| Total | 120 | |
| Maximum Economic Efficiency | 0.98 | |
| Minimum Economic Efficiency | 0.10 | |
| Mean Economic Efficiency | 0.59 | |

**Source: Computed from output of computer programme frontier 4.1 by (Coelli, 1994)**

The least economically efficient farmer will have an efficiency gain of 10.20 (1 – 0.10/0.98) per cent in cocoyam production if he or she is to attain the efficiency level of most economically efficient farmer in the State. The cocoyam farmers in the sample were economically inefficient as a result of allocative inefficiency.

**(c) Sources of Economic Efficiency.**

Table 4. shows the results of the factors influencing economic efficiency of cocoyam farmers in Anambra State. The coefficient for age, education and farm size were highly significant at 1.0% level of probability. This implies that age, education and farm size had a negative relationship with economic efficiency among the farmers sampled. The older a farmer becomes, the more he or she is unable to combine his or her resources in an optimal manner given the available technology (Idiong, 2005). Lau and Yotopoulos (1971) found out that smaller farms were economically more efficient than larger farms within the range of output studied. Most of the farmers (62.5%) had little or no education which implies that education is not costless but requires investment. Lack of education might not be regarded as a factor causing inefficiency.

**Table 4: Maximum likelihood Estimates of the Determinants of Economic Efficiency in Cocoyam Production.**

| Variable | Parameter | Coefficient | Standard Error | t-value |
|---|---|---|---|---|
| Constant term | $Z_o$ | -1.9336 | 0.9670 | -1.9996 |
| Age | $Z_1$ | -0.0456 | 0.0162 | -2.8211*** |
| Education | $Z_2$ | -0.0895 | 0.0319 | -2.8064*** |
| Extension visit | $Z_3$ | 0.0235 | 0.0750 | 0.3133 |
| Family size | $Z_4$ | 0.0146 | 0.0412 | 0.3563 |
| Farm size | $Z_5$ | -5.1097 | 1.0561 | -4.8383*** |
| Farm experience | $Z_6$ | 0.0533 | 0.0220 | 2.4258** |
| Fertilizer use | $Z_7$ | 1.0309 | 0.4036 | 2.5542*** |
| Credit use | $Z_8$ | 0.0968 | 0.3411 | 0.2839 |
| Membership of coop. Societies | $Z_9$ | -0.5344 | 0.3313 | -1.6130 |

**Source: Computed from frontier 4.1 MLE/Survey data, 2005**

Only if it is costless could we say that it would contribute to improvement in efficiency (Shah, 1995). This goes against the findings of Amaza and Olayemi (2000) who reported that increasing years of formal education increases a farmer's level of allocative and technical efficiency which improved their economic efficiency.

Extension visit, family size and credit access were positively signed but were not significant. Fertilizer use was positively signed and significant at 5.0% level of probability. This implies that farmers who use fertilizer were economically efficient. Membership of cooperatives was negatively signed but not significant even at 10% level of probability.

## CONCLUSION

The study has indicated that cocoyam farmers in Anambra State are predominantly women who are not fully economically efficient. Individual levels of economic efficiency range between 10.20% and 98.31% with a mean of 59.42%, which reveal substantial economic inefficiencies hence considerable potential for enhanced profitability by reducing costs through improved efficiency. On average, by operating at full economic efficiency levels cocoyam producers would be able to reduce their cost by 39.70% depending on the method employed.

Important factors indirectly related to economic efficiency are age, education, farm size, farm experience and fertilizer use. These results call for policies aimed at encouraging new entrants especially the youths to cultivate cocoyam and the experienced ones to remain in farming. Women play a significant role in cocoyam production in the study area therefore free education programme especially for the *girl-child* is advocated as well as policies designed to improve women access to fertilizer.

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