

Economic Analysis of Kola-nut Production in Nigeria

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ABSTRACT This study employs a stochastic frontier production function analysis to; examine the productivity, predict the technical efficiency of Kola-nut production in Ondo State, Nigeria, and to identify the factors affecting production, profitability, productivity and technical efficiency (TE) using farm – level survey data collected from 150 Kola-nut farmers selected using multistage sampling technique assisted with interview schedule. Findings from the study show that Kola-nut farmers operated on a very small-scale level and the kola trees are quite old but the enterprise is still very profitable. The productivity analysis shows that while number of kola trees, cost of chemical and labour were efficiently utilized it was not the case with farm distance and age of kola trees whose utilization was already in the stage three of the production region. The return to scale (RTS) of 1.155 shows that Kola-nut production was in the irrational stage of the production surface. The TE varied substantially between 0.496 and 0.986 with mean TE of 0.913. The farmers' socio – economic variables represented by primary occupation and storage facilities contributed positively to technical efficiency of the farmers. The level of education however reduces technical efficiency of the farmers. Kola-nut production could therefore be increased by massive replacement of the old kola trees with new ones as well as putting more hectares to kola-nut production.

INTRODUCTION

In Nigeria, prior to the commercial exploration of petroleum, the agricultural sector was the leading contributor to the Gross Domestic Product (GDP). The agriculture share of the GDP stood at about 90 percent before independence. It was about 56 percent in 1960 – 1969 period. It declined considerably to an average of about 24 percent in 1970 – 1979 period and 22 percent in 1980. It fluctuated between 16 percent and 24 percent between 1981 and 1985 (CBN/NISER 1992). The sector has however, suffered many reverses during the past couple of decades. From era of booming export trade in agricultural commodities, the Nigerian agricultural sector has degenerated to an import dependent one. Subsequently, it has failed to generate significant foreign exchange, feed agro-allied industries, improve the living standards of farming house-holds and rural dwellers and provide effective demand for industrial goods and services. Increasing food production however is vital for enhancing future food security in the country as this is no longer debatable but a necessity. To achieve this, good knowledge of the current efficiency or inefficiency inherent in the crop sub – sector as well as factors responsible for the level of efficiency and inefficiency must be critically examined. This is with a view to enhancing other potentials of the

Nigerian agricultural economy as it offers the greatest potential for employment generation among other sectors of the economy (CBN 2003).

The Various governments in Nigeria in the past were preoccupied with various challenges of diversifying the economy in order to reverse the poor performance of the agricultural sector. Successive governments in the country had embarked on several programmes aimed at boosting agricultural production. These programmes include: River Basin Development Authority (RBDA), 1974, Agricultural Development Projects (ADP) 1974, Agricultural Credit Guarantee Scheme (ACGS) 1978, Green Revolution Programme (GRP) 1980, Directorate of Food, Roads Rural Infrastructure, DFFRI (1986) and most recently are the Youth in agriculture programmes, the single crop initiative programmes and the 50 billion naira credit line for farmers to improve agricultural production in the country. One of the central objectives of these programmes was and still is to increase food production thereby solving the problem of food insecurity and poverty. Unfortunately most of these programmes suffered one defect or the other and the desired results could not be got and thus the problem of food insecurity and poverty lingers on.

The world food council reported that the rate of increase in the number of hungry people in the world in the 1980s was five times what it was in

the 1970's. By 1989, the total number of chronically hungry people was estimated at 550 million people. Africa was reported to have experienced the largest increase in hunger cases between 1970 and 1989. The implication of these projections is that poverty in Nigeria is likely to increase as we approach the year 2010. If this is to be averted, a drastic step has to be taken to achieve a sustained growth in agricultural sector output. This can only be achieved by the articulation of a self-sufficiency policy package that is self-sustaining and which will have the expected impact on the agricultural output of the people. One of such self-sufficiency policy packages is to improve the productivity and efficiency in some cash crop production with the resultant increase in production, farmers' income and employment generations and thus alleviating poverty among the farmers.

Kola-nut is a tropical tree crop with over 20 species, out of which, *Cola nitida* (Gbanja) and *Cola acuminata* (Abata) are the two main species grown in Nigeria. *Cola nitida* however is the only kola-nut of inter-regional and international trade. While the consumption of *Cola acuminata* is greatly cherished by the Yoruba of south-west of Nigeria, the people of the northern and south-east Nigeria prefer the *Cola nitida*. The commodity gets very significant attention during marriage and burial ceremonies and even during everyday entertainment of important visitors where it is offered as valuable gift on such important occasions. In addition to the economic and social importance of kola-nut, it enjoys special favour with the people of northern Nigeria who have accepted the *Cola nitida* as a stimulant substitute for alcoholic drinks. The place of kola-nut production before the dependence of the economy on petroleum cannot be over emphasized (Akinbode 1982). Every year an increasing number of Nigerians earn their living as kola-nut producers, transporters, traders, middlemen and even as professional packing men and is the third most important among the world's stimulants whose production covered about 47 million metric tonnes in 1985 (Michael 1985).

This study seeks to evaluate the profitability and technical efficiency (TE) of Kola-nut production in Nigeria in order to identify the factors affecting production and profitability of the crop. It also identifies traces of inefficiency effects in the production process; predict the TE of the kola-nut farmers in the study area and the

influence of some socio-economic characteristics of Kola-nut farmers on the farm level technical efficiencies.

ANALYTICAL FRAMEWORK

The stochastic frontier production function (SFPF) in efficiency studies is employed in this study. In the SFPF the error term is assumed to have two components parts V and U. The V covers the random effects (random errors) on the production and they are outside the control of the decision unit while the U measures the technical inefficiency effects, which are behavior factors that come under the control of the decision unit. They are controllable errors if efficient management is put in place. The stochastic frontier approach is generally preferred for agricultural research for the following reasons: the inherent variability of agricultural productions due to interplay of weather, soil, pests, diseases and environmental failures and many firms are small family-owned enterprises where keeping of accurate records is not always a priority hence available data on production are subject to measurement errors.

Economic application of stochastic frontier model for efficiency analysis include: Aigner et al. (1977) in which the model was applied to U.S. agricultural data, Battese and Corra (1977) applied the technique to the pastoral zone of eastern Australia. More recently, empirical analysis has been reported by Bravo Ureta and Pinheiro (1993), Ojo (2004).

The stochastic frontier production function model is specified as: $Y_i = f(X_i; \beta) + \varepsilon_i$ where, Y is output in a specified unit, X denotes the actual input vector, β is the vector of production function parameters and ε_i is the error term that is decomposed into two component parts, V and U. The V is a normal random variable that is independently and identically distributed (iid) with zero mean and constant variance (σ^2). It is introduced to capture the white noise in the production, which are due to factors that are not within the influence of the producers. It is independent of U. The U is a non-negative one-sided truncation at zero with the normal distribution (Tadesse and Krishnamoorthy 1997). It measures the technical inefficiency relative to the frontier production function, which is attributed to controllable factors (technical inefficiency). It is half normal, identically and independently

distributed with zero mean and constant variance. The variances of the random errors (σ_v^2) and that of the technical inefficiency effects (σ_u^2) and overall model variance (σ^2) are related thus: $\sigma^2 = \sigma_u^2 + \sigma_v^2$, and the ratio: $\gamma = \sigma_u^2 / \sigma^2$ is called gamma.

Gamma measures the total variation of output from the frontier, which can be attributed to technical inefficiency.

The Technical Efficiency (TE) of an individual firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i^*). The Y_i^* is maximum output achievable given the existing technology and assuming 100 percent efficiency. It is denoted as: $Y_i^* = f(X_i, \beta) + V$, that is, $TE = Y_i / Y_i^*$.

Also the TE can be estimated by using the expectation of U_i conditioned on the random variable (V -U) as shown by Battese and Coelli (1988), that is

$$TE = f(X_i, \beta) + V - U / f(X_i, \beta) + V$$

And that, $0 \leq TE \leq 1$

METHODOLOGY

Study Area: The study was based on farm level data on Kola-nut farmers in Ondo State, Nigeria. Ondo state is in the South Western part of Nigeria. Climatically, the state falls within the rainforest belt of the country with vast agricultural potential. The state enjoys luxuriant vegetation with vast rainforest found in the south while the Northern fringe is mostly sub – savannah forest. The people are peasant farmers who engage in production of cash crops such as cocoa, kola-nut, rubber, oil palm and cashew. Farming practices in the study area involve the use of hand tools and other simple implements.

Data Collection and Sampling Techniques: The data mainly from primary sources were collected from 150 Kola-nut farmers selected using multistage sampling techniques from three Local Governments Areas (LGAs). The three LGAs, Akure North, Odigbo and Ifedore were purposively selected at the first stage. The second stage involved a simple random selection of 50 farmers from each of the three LGAs, making 150 respondents. Data were collected with the use of a structured questionnaire assisted with an interview schedule because of the level of illiteracy in the population sampled. The input data include: age of Kola nut trees (years), number of kola-nut trees (stand), labour (man – days), farm distance (Km) and expenses on chemicals in naira (₦). Data

were also collected on the socio – economic variables; such as, education as number of years spent in school, farming experience, and primary occupation as dummy variable (1 for farming and 0 otherwise).

Data Analysis: Descriptive Statistics (mean, standard deviation), gross margin and the stochastic frontier production function were used to analyze the socio – economic characteristics of the Kola-nut farmers, profitability and technical efficiency of Kola-nut production in the study area respectively.

This production technology of the kolanut farmers was expressed following the adoption of Battese and Coelli (1988) with the explicit Cobb – Douglas functional form specified as follows:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + V_i - U_i$$

Where: Y = Output of kola nut produced (Kg), X_1 = Age of Kola trees (yrs), X_2 = Number of Kola nut trees (stand), X_3 = Labour used (man – days), X_4 = Farm distance (Km), X_5 = Expenses on chemicals (₦).

The inefficiency model (U_i) is defined by:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i}$$

Where: Z_1, Z_2, Z_3, Z_4 represent years of formal education, farming experience, primary occupation and storage facilities respectively. These socio – economic variables were included in the model to indicate their possible influence on the technical efficiencies of the farmers. The β 's, δ 's are scalar parameters to be estimated. The variances of the random errors, σ_v^2 and that of the technical inefficiency effects σ_u^2 and overall variance of the model σ^2 are related thus: $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and the ratio $\gamma = \sigma_u^2 / \sigma^2$, gamma, measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battese and Corra 1977).

For this study, two different models were estimated in the final MLE. Model 1 is the traditional response function of OLS in which the inefficiency effects are not present. It is a special form of the stochastic frontier production function model in which the total variation of output due to technical inefficiency is zero that is $\gamma = 0$. Model two is the general model where there is no restriction. The two models were compared for the presence of inefficiency effects using the generalized likelihood ratio test which is defined by the test statistic, Chi – square, (χ^2), and is defined by: $\chi^2 = -2 \ln \{H_0 / H_a\}$

Where χ^2 has a mixed chi – square distribution

with the degree of freedom equal to the number of parameters excluded in the unrestricted model. H_0 is the null hypothesis that $\gamma = 0$. It is given as the value of the likelihood function for the frontier model and H_a is the alternative hypothesis that $\gamma \neq 0$ for the general frontier model.

RESULTS AND DISCUSSION

Production Performance: The summary statistics of variables involved in Kola-nut production is presented in Table 1.

Table 1: Summary statistics of variables of the stochastic frontier production function for Kola-nut production in Nigeria

Variables	Mean	Std. Deviation
Output of Kola nut (kg)	1718.60	1575.00
Age of Kola trees (yrs)	34.43	13.64
Tree number (stands)	571.33	640.48
Labour (man-days)	621.83	933.80
Farm distance (km)	9.73	5.68
Cost of chemical (₦)	2968.20	4404.30

The mean output of the Kola-nut harvested by farmers was 1,718.6kg with a large variability as shown by the standard deviation of 1,575kg. This implies that the farmers operated at different levels of farm sizes. The average age of Kola was about 35 years, with standard deviation of about 14 years, large variability and mean depict that the kola trees are aged hence its productivity will be very low.

The average number of tree stands was 571 with standard deviation of 640; this indicates relatively low number of trees on the farm. The labour used in Kola-nut production had an average of 621.83 man-days and standard deviation of 933.8 man-days, the findings indicated that production of Kola-nut requires a lot of labour for efficient productivity. Labour was intensively used which required both the use of hired and family labour for the work to be done and for more output to be achieved. The average farm distance of 10Km shows that the farm distance is far from where the farmers reside and on getting to the farm they would have been tired. The average cost of chemical was ₦2968 with standard deviation of ₦4404, this shows that Kola-nut production requires a lot of chemical for viable output.

Profitability Analysis: Kola-nut production was a profitable business in the study area as

shown by the average gross margin of ₦100,769.58. The cost elements in the variable costs include labour cost and cost of agro – chemical. The revenue represents the sales accruing from Kola-nut. The average total revenue of ₦133,856.30 was obtained from the area with a standard deviation of ₦198,772.08. The large variability as defined by the size of the standard deviation implies that farmers operated at different levels of farm size. Thus, the Kola-nut farmers were able to cover their total operating expenses in the study area.

Estimates of Stochastic Frontier Production Function: The estimates of parameters of the stochastic frontier production function are presented in table 2.

Table 2: Estimates of stochastic frontier production function.

Variables	Model 1 (OLS)	Model 2 (MLE)
<i>General Model</i>		
Constant	2.760 (4.99)	*2.623 (3.96)
Kola's age	-0.831 (3.42)	*-0.041 (2.63)
Tree number	0.014 (0.12)	0.036 (0.31)
Labour	0.123 (1.76)	0.798 (1.39)
Farm distance	-0.037 (0.23)	-0.055 (0.35)
Cost of chemical	0.382 (3.08)	*0.418 (2.93)
<i>Inefficiency Model</i>		
Constant	0	-0.713 (0.74)
Education	0	0.022 (1.45)
Experience	0	-0.011 (1.62)
Primary occupation	0	0.256 (1.45)
Storage facilities	0	0.022 (0.07)
Chemical storage	0	0.104 (0.32)
<i>Variance Parameters</i>		
Sigma square	0.165	0.144 (7.08)
Gamma	0	0.077 (1.61)
Log likelihood function	-50.86	-23.56

* Estimate is significant at 5% level of significance

The estimated elasticity of cost of chemical and age of Kola-nut are statistically significant at 5% level, implying that Kola-nut production depends largely on these factors of production, namely age of Kola-nut and cost of chemical. The elasticity of cost of chemical showed decreasing positive function implying that its use was in stage II or diminishing returns to scale of the production region and thus efficiently utilized while age of Kola-nut trees was in stage III of production. The return to scale (RTS), which is the summation of all the estimated elasticities of production, was 1.155, and showed increasing returns to scale because it was greater than unity (Table 3).

Table 3: Elasticity of production and return to scale

Variable	Elasticity of production
Age of Kola	-0.041
Tree number	0.036
Labour	0.798
Farm distance	-0.056
Cost of chemical	0.418
RTS	1.155

This implies that Kola-nut production is in stage I or increasing returns to scale of the production region and thus production is in the irrational stage of production function (Doll and Orazen 1978). At this stage every addition to the production inputs would lead to more than proportionate addition to the output. To move from stage I of the production region to stage II, the use of production inputs need to be increased so that output of Kola-nut is expanded while efforts should be intensified to plant new kola trees.

Technical Efficiency Analysis: The technical efficiency analysis is presented in table 4.

The TE ranged between 0.496 and 0.986 with mean technical efficiency of 0.913. The decile range distribution of the TE showed that about 87.48% of the Kola-nut farmers had technical efficiencies of 0.80 and above. The remaining 12.52% of the farmers had technical efficiencies of less than 0.80. The study revealed that the sampled farmers were relatively very technically efficient, meaning that more than half of the farmers obtained maximum output from a given set of inputs with a reduce level of resources wastage.

Table 4: Decile Range of Frequency distribution of Technical Efficiency

Decile range of T.E	Percentage
0.41 – 0.49	2.7
0.50 – 0.59	2.7
0.60 – 0.69	5.3
0.70 – 0.79	2.0
0.80 – 0.89	30.0
0.90 – 1.00	57.3
Total	100.0
Minimum (TE)	0.495
Maximum (TE)	0.986
Mean (TE)	0.913

CONCLUSIONS

Kola-nut production is a profitable venture. The return to scale of kola-nut production is in stage I and thus, its production is inefficient in the study area. This was corroborated by the significant presence of technical inefficiency effects in the production process. The kola-nut farmers were relatively technically efficient in the study area.

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