

Original Research Article

Economic Efficiency Analysis of Pineapple Production in Edo State, Nigeria: A Stochastic Frontier Production Approach

Keys: Green Colour means; RETAIN/COMMENT; Red Colour means; DELECT/DISCARD/RECAST

ABSTRACT

This study analyses farmers' overall efficiency in ~~Pineapple~~ pineapple (avoid the use of Cap-lock for pinneapple) production in Edo State, Nigeria. Data were collected through well structured questionnaire administered on 175 ~~Pineapple~~ pineapple (avoid the use of Cap-lock for pinneapple) farmers selected using a multi-stage sampling technique and analyzed using descriptive statistics and the stochastic frontier production and cost function models. ~~The Result of the study~~ revealed that while farm size and labour significantly influenced production efficiency, the cost of farm ~~and~~, suckers and output were significant in influencing cost efficiency. ~~The mean average~~ technical, allocative and economic efficiencies of the farmers were 0.70, 0.68 and 0.64 respectively indicating ample opportunity for farmers to increase their productivity ~~through improvement in their technical and allocative efficiencies.~~ (Avoid repetition of findings).The return to scale (RTS) for the production function revealed that the farmers operated in the rational zone (stage II) of the production surface having an RTS of 0.52. The analysis further indicated that the presence of technical and allocative inefficiencies had effect on ~~Pineapple~~ pineapple (avoid the use of Cap-lock for pinneapple) production as depicted by the significant estimated gamma coefficient of each model and the predicted technical and allocative efficiencies within the farmers. The study recommends the need to increase output through more intensive use of land, availability of high yielding ~~P~~ pineapple (avoid the use of Cap-lock for pinneapple) varieties and the effective and efficient utilization of labour and fertilizer inputs. It also recommends that farmers be encouraged to join cooperatives and extension services should intensify their efforts in training and mobilizing farmers for improved Pineapple ~~P~~ pineapple (avoid the use of Cap-lock for pinneapple) production. An easier access to credit from formal sources, notably micro-credit institutions and farmers' education are essential to improve productivity and profitability of Pineapple ~~P~~ pineapple (avoid the use of Cap-lock for pinneapple) production in Nigeria. Policies that focuses on ways of attracting and encouraging the youths who are agile and stronger to embark on Pineapple~~P~~ pineapple (avoid the use of Cap-lock for pinneapple) production should be pursued such as the setting up of fruit processing factories or industries in the rural areas. (Kindly choose two major/key recommendation from your finding)

Keywords: *Pineapple (Include), Allocative Efficiency, Economic Efficiency, Stochastic Frontier Production and Cost Models, Technical Efficiency*

1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Pineapple (*Ananas comosus* L. Merr.), the third most important tropical fruit in the world after banana and citrus (Loeillet, 1997; Bartholomew *et al.*, 2003), is a delicious fruit with exceptional juiciness and immense health benefits (Joy, 2010) as well as fine flavour and high nutritive value (Amao *et al.*, 2011 and Baruwa, 2013). Its content makes it a good raw material in confectionery industries for making sweet, fruit drinks and household food additives (Hasegawa ~~et al.~~ *et al.*, (use) 1996). Important producing countries are Thailand, Brazil, India, China, Philippines, Nigeria, Mexico, Australia and Colombia (Esiobu *et al.*, 2014). These countries produce the fruit primarily for fresh fruit markets and the processing industry. Nigeria is ranked 7th on the list for world Pineapple production as well as the leading producer in Africa with a production of 1,400,000 metric tonnes of fresh Pineapple having the largest land area of about 180,000 hectares (ha) for Pineapple (avoid the use of Cap-lock for pineapple) production in the world and yield of 7,778 tonnes/ha (FAOSTAT, 2011).

Until recently, about 80% of Pineapples produced in Nigeria came from small scale farms managed under mixed cropping system. Recent access to international markets, enhanced value of fresh fruits, resuscitation of Pineapple cultivation and local processing have encouraged the development of few large scale farms where Pineapple is produced as a mono crop (Adesope *et al.*, 2009). Despite Nigeria's position and potential in Pineapple (avoid the use of Cap-lock for pineapple) production in the world and the enormous economic advantages the country has over the crop, Nigeria has the lowest productivity of about 7 tonnes/ha when compared with the other nine top producers in the world thereby, contributing a small share (5%) of the world Pineapple production (FAOSTAT, 2010 and Mark, 2010) thus, reflecting a low yield in Pineapple production in the country (Mark, 2010). Adegbite *et al.* (2014) reported that Nigeria's inability to fully tap into the economic potentials of the crop might be a reflection of its inefficient nature in Pineapple production.

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers alike (Omonona *et al.*, 2010; Onubuogu *et al.*, 2014; you should also mention one or more researchers who worked on efficiency). It is no surprise therefore, that considerable efforts have been devoted to the analysis of farm production efficiency in developing countries, Nigeria inclusive. The modern theory of efficiency dates back to the pioneering work of Farrell (1957) who proposed that the efficiency of a firm consist of technical and allocative components and the combination of these two components provides a means of economic efficiency (Orewa and Izekor, 2012). Technical efficiency is the ability of a firm to produce a given level of output with minimum quantity of inputs under a given technology. Allocative efficiency is a measure of the degree of success in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of these inputs. Economic efficiency is a product of technical and allocative efficiency (Olayide and Heady, 1982).

An important assumption relating to efficiency measurement is that firms operating on the outer bound production function, that is, on the efficiency frontier are said to be technically efficient while firms that fail to operate on the outer bound production function are technically inefficient. One way farmers can raise productivity is improving the efficiency within the limit

of the existing resource base and technology (Udoh, 2005). Productivity is reduced in the presence of technical inefficiency whereas the more efficient the firm, the higher its productivity, ceteris paribus (Kumbhakar, 2004). Boosting Pineapple production would require that resources be use efficiently since efficiency in the use of the production inputs is essential for optimum production. Therefore, there is the need to assess the level of efficiency of resources used in agricultural production in general and Pineapple production in particular. This paper contributes to the efficiency literature in developing country agriculture by quantifying the level of technical, allocative and economic efficiencies for a sample of Pineapple farmers in Edo State, Nigeria. The study specifically seeks to:

- i. estimate the technical relationships between inputs and output in Pineapple production;
- ii. estimate the technical, allocative and economic efficiencies of Pineapple farmers in Edo State; and
- iii. identify the factors that determine their levels of efficiency in production.

It is expected that the findings would help in providing information and solution to the declining productivity and yield of Pineapples per hectare thereby leading to improvement in Pineapple Pineapple (avoid the use of Cap-lock for pinneapple) production.

1.2 RESEARCH HYPOTHESES

- i. There is no significant relationship between inputs and output in Pineapple production; and
- ii. Pineapple farmers' socio-economic characteristics have no influence on the technical and allocative efficiencies of Pineapple Pineapple (avoid the use of Cap-lock for pinneapple) production.

2. THEORETICAL FRAMEWORK

The stochastic frontier production function was independently proposed by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977). The stochastic production function is defined by:

$$Y_i = f(X_i, \beta) \varepsilon_i \quad (1)$$

with

$$\varepsilon_i = V_i - U_i \quad (2)$$

Where Y_i is the observed output of the i^{th} sampled farm, $f(X_i, \beta)$ is a suitable functional form, β is vector of the unknown parameters to be estimated, ε_i is the error term made up of two additive components; V_i is the random error having zero mean which is associated with random factors outside the farmers' control such as topography, weather, measurement errors, disruptions of supplies and is assumed to be independently and identically distributed normal $(0, \sigma^2_v)$ random variable and independent of U_i and on the other hand, U_i is a non-negative truncated half normal random variable associated with farm specific factors, which lead to the i^{th} farm not attaining maximum efficiency of production. The U_i is associated with technical inefficiency of the farm and range between zero and one and follows an identical and independent half normal distribution $N(0, \sigma^2_u)$ with N representing the number of farms involved in the cross sectional survey.

Given suitable distributional assumptions for the error terms, direct estimates of the parameters can be obtained by either the Maximum Likelihood Method (MLM) or the Corrected Ordinary Least Squares Method (COLS). However, the MLM estimator has been found to be asymptotically more efficient than the COLS (Coelli, 1995).

122 The technical efficiency of an individual farm from above can be defined in terms of the ratio
 123 of the observed output to the corresponding frontier output, given the available technology.
 124 Hence the technical efficiency of the farmer is expressed as:

$$125 \text{ Technical efficiency (TE)} = Y_i / Y_i^* \quad (3)$$

127 Where,

128 Y_i is the observed output and Y_i^* is the frontier output. Therefore,

$$129 \text{ TE} = f(X_i, \beta) \exp(V_i - U_i) / f(X_i, \beta) \exp(V_i) = \exp(-U_i) \quad (4)$$

130 This is such that $0 \leq TE_i \leq 1$

131
 132 The stochastic frontier production function model is established using the maximum
 133 likelihood estimation procedures (MLE). The strength of the stochastic frontier approach is
 134 that it deals with the stochastic noise and permits statistical test of hypotheses pertaining to
 135 the structure and degree of inefficiencies. Its limitations are:

- 136 * There is no a priori justification for the selection of any particular distribution for the
- 137 technical inefficiencies effects, U_i ;
- 138 * Efficiency measures may still be sensitive to distributional assumptions; and
- 139 * The Cobb -Douglas has constant input elasticities and return to scale for all firms.

140
 141 The corresponding stochastic frontier cost function model for estimating the farm overall
 142 economic efficiency is specified as:

$$143 C_i = g(P_i, \alpha) \exp(V_i + U_i) \quad (5)$$

144 Where C_i = represent the total input cost of the i^{th} farm; g = is the suitable functional form; P_i
 145 = represent input prices employed by the i^{th} farm; α = parameters to be estimated and V_i and
 146 U_i are the error terms and assumed to be independent and identically distributed truncations
 147 (at zero) of the $N(v, \sigma^2)$ distribution.

148
 149 However because inefficiencies are assumed to always increase costs, error component
 150 have positive sign. The farm-specific cost efficiency is defined as the ratio of the observed
 151 total cost of production to minimum cost. But economic efficiency is the inverse of the cost
 152 efficiency (Ogundari *et al.* 2006). Therefore, the farm specific economic efficiency (EE)
 153 is defined as the ratio of minimum production cost (C^*) to actual production (C).

154 That is:

$$155 \text{ EE} = C^* / C \quad (6)$$

156 Hence, a measure of farm specific allocation efficiency (AE) was obtained from technical and
 157 economic efficiencies as:

$$158 \text{ AE} = \text{EE} / \text{TE} \quad (7)$$

159 This means that $0 \leq AE \leq 1$.

160
 161 Several empirical applications have followed the stochastic frontier specification. These
 162 studies are basically based on Cobb-Douglas function and transcendental logarithmic
 163 (translog) functions that could be specified either as production or cost function (Udoh and
 164 Akintola, 2001; Rahman *et al.* 2005; Alabi *et al.* 2010; Usman *et al.* 2010; Abu *et al.* 2012).

165

166 3. MATERIAL AND METHODS

167

168 3.1 THE STUDY AREA

169

170 This study was conducted in two Local Government Areas (LGAs) of Edo State, Esan West
 171 and Ovia South-West LGAs. The State is made up of 18 LGAs and has Benin City as the
 172 State capital. Edo State is situated between Latitudes $05^{\circ}44'N$ and $07^{\circ}34'N$ and Longitudes
 173 $05^{\circ}4'E$ and $06^{\circ}45'E$ (Microsoft Corporation, 2009). The State has an estimated land mass of
 174 $19,794 \text{ km}^2$ and share boundaries with four other states of the federation, namely: Kogi State

to the North, Ekiti and Ondo States to the West and Delta State to the East and South (Source). Edo State has a population of 3,209,434 3,218,332 persons (NPC, 2006 and NBS, 2007) given it a projected population of 3,867,105 persons for 2013 based on a population growth rate of 3.2%. The climate of the State is typically tropical with two major seasons: the wet (rainy) season and the dry (harmattan) season. The wet season lasts from April to November and the dry season lasts from December to March. Agriculture dominates economic activities in the State and the common agricultural crops cultivated in the area include various cash crop among which is a pineapple. as rubber, oil palm, kola nuts, cashew and cocoa and food crops such as cassava, rice, maize, yam and groundnut. Major fruits and vegetables cultivated in the State include citrus, , pawpaw, guava, coconut, mangoes, pears, plantain and bananas, tomatoes, peppers, amaranthus spp., okra, melon, water leaf and cherry.

3.2 SAMPLING PROCEDURE AND SAMPLE SIZE

For this study, A multi-stage sampling technique was used to select the study area and sample size. Esan West and Ovia South-West LGAs were purposively selected due to the high population of Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers in the LGAs area. Five communities were then purposively selected from each of the two LGAs based on the high number of Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers in the respective communities. The communities selected include Emuhi, Ughiyiokho, Ujamen, Uke, and Uhi for Esan West LGA while Ogubazuwa, Iguoriaki, Okoro, Udo, and Ugboqui were the communities selected for Ovia South-West LGA. A reconnaissance survey conducted with the aid of village extension agents (VEA) of Edo State Agricultural Development Programme (EADP) in the study area informed the population of 1,748 Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers out of which a sample size of 175 respondents, representing 10 percent of the population, was randomly drawn from the Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers in the study area.

3.3 METHOD OF DATA COLLECTION

Primary and secondary data were used for this study. The primary data were collected by means of structured questionnaire and interview schedules administered to one hundred and seventy-five (175) Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers selected for the study during the 2012/2013 cropping season. On the other hand, the secondary data were obtained from relevant publications.

The data collected include the socio-economic characteristics of the Pineapple Pineapple (avoid the use of Cap-lock for pineapple) producers (such as age, sex, marital status, household size, years of schooling, years of experience in Pineapple production, cooperative membership and extension contacts), the input and output data (consisting of farm size (ha), family and hired labour (man-days), number, quantity and weight of suckers (kg), fertilizers (kg) and Pineapple harvested (kg) and market prices of all inputs employed in production and output) as well as respondents' perceived problems affecting the economic production of Pineapple in the study area.

3.4 METHOD OF DATA ANALYSIS

In order to achieve the objectives for this study, descriptive statistics (mean and standard deviation) and the stochastic frontier production and cost function models were used to analyze the socio-economic characteristics and the technical, allocative and economic efficiencies respectively of the farmers.

The stochastic frontier production model developed by Aigner *et al.* (1977) was employed in this study to determine respondents' productivity and technical efficiency. The parameters of the model were obtained by the use of maximum likelihood estimation method using the computer software FRONTIER 4.1 (Coelli, 1994). The model in its general form is as specified in equations 1 and 2 above. The production technology is assumed to be characterized by Cobb-Douglas production function. The Cobb-Douglas production function has advantage over other forms of production functions like the Linear and Semi-log production functions in that a logarithmic transformation provides a model which is linear in the log of input and hence, easily used for econometric studies (Coelli, 1995). The Cobb-Douglas production model is specified and defined by:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + V_i - U_i \quad (8)$$

Where Y_i = output of Pineapple (kg); β_0 = constant or Intercept of the model; $\beta_1 - \beta_4$ = regression coefficients; X_1 = quantity of suckers (kg); X_2 = quantity of fertilizers used (kg); X_3 = labour used (Man-days); X_4 = farm size (Ha); V_i = random error term; $\ln$ = logarithm to base e and U_i = technical inefficiency effect predicted by the model and the subscript i indicate the i^{th} farmer in the sample.

The corresponding stochastic frontier cost function model for estimating the farm overall economic efficiency in its general form is as specified in equation 5 above. A Cobb-Douglas functional form was also employed to the model of Pineapple (avoid the use of Cap-lock for pineapple) production in this study because the functional form has been used in many empirical studies, particularly, those relating to developing country agriculture and also meets the requirement of being self-dual. The Cobb-Douglas cost frontier functional form for Pineapple farm is specified as follows:

$$\ln C = \alpha_0 + \alpha_1 \ln P_1 + \alpha_2 \ln P_2 + \alpha_3 \ln P_3 + \alpha_4 \ln P_4 + \alpha_5 \ln Q + V_i + U_i \quad (9)$$

Where, C = total input cost of production of Pineapple farm (₦); $\ln$ = logarithm to base e ; P_1 = cost of labour (₦); P_2 = Average cost of sucker (₦); P_3 = Average cost of Fertilizer (₦); P_4 = Average cost of farm size (₦) and Q = quantity of output (Kg).

3.5 INEFFICIENCY EFFECT MODEL

In the analysis of farmer's efficiency/inefficiency, it is not the average of the observed relationship between the farmers' inputs and output that is of interest but the maximum possible output that is obtained from a given combination of inputs. Not all producers are technically efficient as opposed to conventional microeconomic theory; such statement implies that not all producers are able to utilize the minimum quantity of required inputs in order to produce the desired quantity of output given the available technology. Similarly, not all producers are able to minimized necessary costs for the intended production of output.

From a theoretical point of view, producers do not always optimize their production functions. The production frontier characterizes the minimum number of necessary combinations of inputs for the production of diverse products, or the maximum output with various input combination and a given technology. Producers operating on the production frontier are considered technically efficient, while those who operate under the production frontier are denoted technically inefficient.

In line with Ray (1988) and Sharma *et al.* (1999), the determinants of technical and allocative inefficiency effects can be estimated as:

$$U_{it} = \alpha_0 + \alpha_i Z_{it} \quad (10)$$

Where U_i is technical and allocative inefficiency effects, Z_{it} is the vectors of explanatory variables associated with the technical and allocative inefficiencies and α_i is vector of unknown parameters to be estimated.

An explicit equation can be expressed as:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8 \quad (11)$$

Where U_i = technical and allocative inefficiency effects; Z_1 = age of the farmer (years); Z_2 = farming experience (years); Z_3 = educational level of the farmer (years); Z_4 = household size (Number); Z_5 = sex of the farmer (dummy; 1=male and 0= female); Z_6 = extension visit(Number) (Number of visit per month or Number of visit in 2012/2013 farming seasons; RECAST); Z_7 = membership of cooperative society (Years of participation) (Does it mean all the pineapple farmers are members of cooperative society); Z_8 = marital status (dummy; Married = 1 and Single = 0); α_0 = constant or intercept and $\alpha_1 - \alpha_8$ is the scalar parameters to be estimated.

These were included in the model to indicate their possible influence on technical and allocative efficiencies of the farmers and to satisfy objective (iii). The estimates for all the parameters of the stochastic frontier production and cost functions and inefficiency model were obtained using the programme FRONTIER 4.1 (Coelli, 1994).

4. RESULTS AND DISCUSSION

4.1 ESTIMATES OF STOCHASTIC FRONTIER PRODUCTION FUNCTION

The maximum likelihood estimates (MLE) of the parameters of the stochastic frontier production function for Pineapple farmers are presented in Table 1.

REVISIT Table 1 and Table 2

Table 1: Stochastic Frontier Cobb-Douglas Production Function for Pineapples

Variables	Coefficient	Standard Error	T-Ratio
Production Model			
Constant	9.84	1.01	9.72*
Suckers	-0.18	0.12	-1.51
Fertilizers	0.08	0.14	0.61
Labour	0.17	0.09	1.85***
Farm Size	0.45	0.13	3.48*
Inefficiency Model			
Constant	-1.26	2.52	-0.50
Age	-0.004	0.03	-0.16
Farming experience	-0.21	0.09	-2.44**
Education	-0.04	0.05	-0.84
Household size	0.02	0.08	0.21
Gender	5.14	2.84	1.81***
Extension visits	-2.13	0.98	-2.17**
Membership of cooperatives	0.12	0.07	1.71***
Credit accessibility	-0.000001	0.000002	-0.50
Marital status	-1.61	0.97	-1.66***
Diagnostic statistics			
Sigma-squared (δ^2)	2.35	0.61	3.87*
Gamma(Γ)	0.65	0.12	5.45*

* Significant at 1% probability level; ** Significant at 5% probability level; *** Significant at 10% probability level; Indicate Field Survey Data (Year of the Analysis), Also indicate the Statistical software used for the Analysis

What of the values the Log Ratio (LR) test. This analysis is unclear. You cannot make logical conclusion without LR. Your H_0 cannot be concluded without LR. So you have to revisit your ANALYSIS

The sigma-squared (2.35) of the estimated model was statistically significant at 1% and different from zero. This indicates a good fit and the correctness of the distributional form assumed for the composite error term. The variance ratio, known as gamma (γ) which is associated with the variance of technical inefficiency effects in the stochastic frontier, is estimated to be 0.65 indicating that systematic influences that are unexplained by the production function are the dominant sources of random error. This means that 65% of the variation in output among the Pineapple farmers was due to disparities in technical efficiency.

The analysis of the estimated model revealed that the coefficient of farm size was positive and statistically significant at 1% level. The positive relationship with output conforms to a priori expectation suggesting that a 1 unit increase in farm size will result to a 0.45 unit increase in output. This means that there is scope for increasing output by expanding farmland.

Labour was positive with a coefficient of 0.17 and significant at 10% level. This implies that labour is a significant factor that influences changes in output of Pineapple. The positive coefficient is in agreement with the expected sign and implies that as the amount of labour increases, output also increases; this type of relationship is however expected where the available labour is efficiently managed along with other inputs to avoid redundancy and diminishing return to labour.

The coefficient of fertilizer was positive and in accordance with the expected sign meaning that quantity of fertilizer applied was directly related to the output while the statistical insignificance of its coefficient implies that fertilizer was not a significant factor in Pineapple production.

The coefficient of suckers was estimated to be negatively related to output but not significant. The inverse relationship indicates that as the quantity of sucker increases, quantity of Pineapple produced decreases. This can probably be attributed to improper spacing of Pineapple suckers during planting since farmers in the study area used it as a means of controlling weed. Thus productivity tends to be low.

4.2 TECHNICAL EFFICIENCY OF PINEAPPLE FARMERS IN THE STUDY AREA

The technical efficiency of the Pineapple farmers in the two selected Local Government Areas is presented in Table 2. The technical efficiency of farmers in Esan West Local Government Area ranged from 0.98 to 0.04 with a mean TE of 0.31. This implies that on the average the respondents are able to obtain about 31% of potential output from a given mix of production inputs. Thus, in the short-run, there is scope for increasing Pineapple production by 69% by adopting the technologies or techniques used by the most technical efficient farmers in Pineapple production.

Table 2: Technical Efficiency of Pineapple Production in the Study Area

Technical Efficiency Estimates	Local Government Area		
	Esan West	Ovia South-West	Both LGAs
Maximum	0.98	0.88	0.91
Mean	0.31	0.60	0.70
Minimum	0.04	0.33	0.03
Standard Deviation	0.21	0.20	0.19
Coefficient of Variance	1.48	0.33	0.27

Source; Indicate Field Survey Data (Year of the Analysis), Also indicate the Statistical software used for the Analysis

The technical efficiency of Pineapple farmers in Ovia South-West LGA ranged from 0.88 to 0.33, with a mean TE 0.60. This implies that on the average, the respondents are able to obtain about 60% of potential output from a given mix of production inputs. Thus, in the short-run, there is scope for increasing Pineapple production by 40% by adopting the technologies or techniques used by the most technical efficient farmers in Pineapple production. The results of the technical efficiency showed that farmers in Ovia South-West LGA were relatively more technically efficient than farmers in Esan West LGA.

4.3 DETERMINANTS OF TECHNICAL INEFFICIENCY

The variables influencing inefficiency were specified as those relating to farmers' socio-economic characteristics. The results of the analysis of the determinants of technical inefficiency are presented in Table 1. Analysis of the estimated coefficient of the inefficiency variables of the efficiency model tells us the contribution of the variables to technical inefficiency. Since the dependent variable of the function represents inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency and a negative sign indicates the reverse. That is, a negative sign on parameter inefficiencies means that the variable reduces technical inefficiency while a positive sign increases technical inefficiency.

Farming experience is negative and significantly related to technical inefficiency at 5% level. This implies that farmers with more years of farming experience are expected to have less level of inefficiencies. This result is in line with that of Oluwatusin (2011) who reported that with increased years of experience, farmers become more specialized which means that they must have acquired more skill and good experience in production. This finding also agrees with those of Onu *et al.* (2000) who reported a negative relationship with respect to farming experience thus suggesting that older farmers are relatively more efficient and vice versa. It is possible that such farmers gained more farming experience through "learning by doing" and thereby becoming more efficient.

The coefficient of gender was estimated to be positive and significantly related to efficiency at 10% level of probability, suggesting that inefficiency is less among female than male. This is contrary to a priori expectation, because men are usually more endowed with resource inputs than women. However, women generally control smaller farmlands than men and appear keener in planting vegetables and fruits for family consumption than their male counterparts who normally devote their time to the production of cash crops for income (Agyare, 2010). Another plausible reason can be attributed to the older age of the male farmers involved in Pineapple production in the study areas compare to women as this tends to make them less efficient than the women. However, previous studies as reported by Tchale and Sauer (2007) had found gender to have no significant impact on efficiency.

The coefficient of contact with extension agents was negative and statistically significant at 5% level and this agrees with a priori expectations. This implies that farmers that had more contact with extension agents tend to be less inefficient than their counterpart with less/no contact with extension agents. The implication is that farmers having more contact with extension agents are able to get information about the state of latest agricultural technology, pest management and proper and timely use of agricultural inputs. Similar result was indicated by Hassan (2004).

The coefficient of membership of cooperative association was reported positive and significantly related to technical inefficiency at 10 % level of probability. This is contrary to a priori expectation implying that farmers who are members of association are less efficient. Membership of association can be very valuable for small-scale farmers because it facilitate access to market, secure market for their crops as well as provide some technical assistance. The study showed only few farmers were members of cooperative societies and were mostly new entrants irrespective of their years of farming and as such most of the benefits of being a member eluded them. This finding was consistent with those of Onyenweaku and Ohajianya (2005) who reported that farmers with wealthy households, sufficient experience in farming and with excess labour tend not to be involved in collective action which is consistent with theoretical prediction. Another possible explanation could be that Pineapple farmers in the study area regard membership of cooperatives as a “public good” and not as a “social good” where they fraternize not necessarily for farming or production motives.

In accordance with a priori expectation, the coefficient of access to credit was negative but not significantly related to inefficiency. This implies that farmers having access to credit are technically more efficient than farmers with less/no access to credit. The finding of this study conformed to the finding of Idiong (2007). The obvious reason for this relationship may be that credit availability improves farmers' liquidity and facilitate the purchase of inputs like fertilizers, herbicide and other farm implement during peak season.

The coefficient of marital status was negative and statistically significant at 10% level of probability, implying that the variable had the effect of reducing the farmers' technical inefficiency. Married respondents were more efficient than the single ones who are into Pineapple farming. Since marital status is correlated with household size, large household size is a source of labour for most farm operations (Dimelu *et al.*, 2009). More adult persons in the household meant more quality labour would be available for carrying out farm activities.

4.4 ELASTICITY OF PRODUCTION AND RETURN TO SCALE

The elasticity of production measures the responsiveness of output to changes (increase or decrease) in inputs. Table 3 showed results of the production elasticities for the inputs in the Cobb-Douglas frontier function. The estimated elasticity of production of farmers in Esan West LGA showed increasing return to scale. Quantity of suckers, fertilizer, labour and farm size showed positive increasing return to scale implying efficient allocation of the variables in the production process in the study area. For Ovia South-West LGA, the elasticity of quantity of suckers, labour and fertilizer showed positive decreasing return to scale except for farm size whose elasticity showed negative return to scale, implying inefficient allocation. As observed in Table 3, all the inputs elasticities are inelastic; a 1% increase in each input results in less than 1% increase in yield. The RTS parameter (0.52) was obtained from the summation of the coefficients of estimated inputs (Elasticities) which indicate that Pineapple production in the study area is in the stage II of the production surface. Stage II is the

economic relevance stage of production (the rational Stage) where inputs and production are believe to be efficient. Hence, it is advisable that the production units should maintain the level of input utilization at this stage as well as ensure maximum output from given level of inputs. However, they can do well by increasing their level of fertilizer, labour and farm size.

Table 3: Elasticity of Production and Return to Scale UNCLEAR

Variables	Esan West	Ovia South-West	Elasticity
Sucker	0.73	0.09	-0.18
Fertilizer	0.01	0.44	0.08
Labour	0.32	0.43	0.17
Farm size	0.45	-0.40	0.45
RTS	1.51	0.66	0.52

Source; Indicate Field Survey Data (Year of the Analysis), Also indicate the Statistical software used for the Analysis

You also have to indicate the real or shadow prices of the inputs here; I mean from the model you stated early

P₁= cost of labour (₦); P₂= Average cost of sucker (₦); P₃ = Average cost of Fertilizer (₦); P₄=Average cost of farm size (₦) and Q = quantity of output (Kg).

4.5 THE ESTIMATES OF STOCHASTIC FRONTIER COST FUNCTION

The estimated parameters for the stochastic cost function are presented in Table 4. The result revealed that the variance of the parameter estimates, sigma squared (δ^2), was positive (22) and was statistically significant at 1% level of probability. Gamma (γ) coefficient was 0.78 and was also statistically significant at 1% level of probability. The estimated gamma (γ) parameter of 0.78 implies that about 78% of variations in the total cost of production of Pineapples were due to differences in the cost efficiencies. This means that the cost inefficiency effect do make significant contributions to the cost of producing Pineapple in the study area.

Apart from cost of fertilizer which has a negative coefficient, all other explanatory variables included in the model had positive coefficients and were significant at different level of probability, indicating that as the cost of these variables increase, total cost of production increases and vice visa. The positive relationship between the level of output and the total cost of production implies that as the total output increases by 1%, total cost of production will also increase by 0.15%. The cost of labour, farm size and suckers had direct relationship also with total cost of production and are significant at different probability levels. This implies that a unit increase in any of these variables will increase their total cost of production by 0.32%, 0.06% and 1.71% respectively, ceteris paribus.

Table 4: Estimates of the Stochastic Frontier Cost Function for Pineapple Production

Variables	Coefficient	Standard Error	T-Ratio
Cost Model			
Constant	10.80	0.23	46.10*
Average cost of labour	0.06	0.03	1.72***
Average cost of suckers	0.32	0.04	9.08*
Average cost of fertilizers	-0.03	0.07	-0.51
Average cost of farm land	1.71	0.16	10.51*
Output	0.15	0.03	4.92*

549	Inefficiency Model			
550	Constant	1.49	0.15	9.87*
551	Age	0.001	0.00	0.24
552	Farming experience	-0.331	0.147	-2.25**
553	Education	0.002	0.01	0.31
554	Household size	0.02	0.01	1.78***
555	Gender	-0.21	0.10	-2.07**
556	Extension visits	0.11	0.08	1.44
557	Membership of cooperatives	-0.03	0.01	-2.37**
558	Credit accessibility	-0.23	0.07	-3.11*
559	Marital status	-0.31	0.21	-1.48
560				
561	Diagnostic Statistics			
562	Sigma-squared	0.22	0.03	8.05*
563	Gamma	0.78	0.21	3.71*
564				

565 * Significant at 1% probability level; **Significant at 5% probability level; *** Significant at 10%
566 probability level

567 568 **4.6 DETERMINANTS OF ALLOCATIVE INEFFICIENCY**

569
570 It is evidence from Table 4 that farming experience, household size, gender, membership of
571 cooperative society and credit accessibility variables are significantly related to allocative
572 inefficiency at different level of probability, while age, education, extension visits and marital
573 status variables had no significant effect on allocative inefficiency of Pineapple production in
574 the study.

575
576 The coefficient of farming experience is negative and statistically significant at 5 percent,
577 implying more years of farming help reduce allocative inefficiency. The household variable
578 has a positive and significant effect on allocative inefficiency at 10% level of probability
579 which implies that increase in the household size will increase total production thereby
580 increasing allocative inefficiency.

581
582 The coefficient of gender was negative and significant at 5% level, which shows that women
583 who are involved in Pineapple production are more allocative efficient than their male
584 counterparts. Findings from previous studies revealed that women produce and process
585 food, using diverse coping strategies for ensuring food security for their household than their
586 male counterparts.

587
588 The coefficient of access to credit had negative and significant effect on allocative
589 inefficiency at 1% level. The result of the study indicates that farmers having good access to
590 credit are allocatively less inefficient than their counterparts having poor or no access to
591 credit. The possible reason for this relationship may be that better access to credit improves
592 farmers' liquidity and ensures timely and proper application of farming inputs.

593
594 The coefficient of membership of cooperatives was negative and significantly related to
595 allocative inefficiency at the 5% level. Result of the study indicates that farmers who belong
596 to cooperative societies were more allocative efficient than those who are not members. This
597 implies that farmers that belong to cooperative societies are more able to get information
598 from extension agents about pest management, spacing, quantity of inputs, proper and
599 timely application of inputs and better access to market.

4.7 DISTRIBUTION OF EFFICIENCIES AMONG PINEAPPLE FARMERS

The result of the general distribution of Pineapple farmers' efficiencies presented in Table 5 indicates that the Technical efficiency (TE) ranges between 0.03 and 0.91 with the mean technical efficiency of 0.704. The average technical efficiency index of 0.70 suggests that an average Pineapple farmer in the study area still has the capacity to increase technical efficiency in Pineapple production by 30% to achieve the maximum possible level.

Table 5: Technical, Allocative and Economic Efficiencies of Pineapple Production

Efficiency level	Technical efficiency		Economic efficiency		Allocative efficiency	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.01-0.3	12	3.6	-	-	20	11.4
0.31-0.4	8	2.4	-	-	8	4.6
0.41-0.5	16	4.8	8	4.6	17	9.7
0.51-0.6	20	6.1	13	7.4	13	7.4
0.61-0.7	41	12.4	57	32.6	19	10.9
0.71-0.8	46	13.9	76	43.4	19	10.9
0.81-0.9	32	9.7	21	12.0	37	21.1
0.91-1.0	-	-	-	-	42	24.0
Total	175	100.0	175	100.0	175	100.0
Mean		0.704		0.643		0.684
Std. deviation		0.188		0.093		0.263
Minimum		0.03		0.42		0.02
Maximum		0.91		0.87		0.99

Source; Indicate Field Survey Data (Year of the Analysis), Also indicate the Statistical software used for the Analysis

It therefore, shows that there is efficiency gap but with scope for improvement in Pineapple production among Pineapple farmers in the study area. These results compare favourably with the findings of Ekunwe and Orewa (2007), Ogundari and Ojo (2007), Ekunwe *et al.* (2008), Ojo *et al.* (2009) and Shehu *et al.* (2010). The sample frequency distribution indicated a clustering of technical efficiency in the region 0.71 - 0.80 efficiency ranges representing 14% of the respondents.

The estimated economic efficiencies (EE) differs substantially among the farmers and ranged from 0.42 to 0.87 with an average of 0.643 (Table 5). This mean that if the average farmer in the sample area were to reach EE level of its counterpart, then the average farmer could experience a cost saving of 26% (i.e $1 - (0.643/0.87) \times 100$) while the most inefficient farmer suggests a gain in economic efficiency of 52% (i.e $1 - (0.42/0.87) \times 100$). The frequency distribution indicate that about 43% of farmers had economic efficiencies between 0.71-0.80 while 88% of the respondents had EE of 0.61 and above. That is, majority of the farmers were efficient in producing at a high economic efficiency.

The allocative efficiency (AE) of the sample farmers ranged from 0.02 to 0.99 with the mean value of 0.684. This implies that if the average farmer in the sample area were to reach AE

level of its most efficient counterpart, then the average farmer could experience a cost saving of 31% (i.e $1-(0.684/0.99)*100$) while the most inefficient farmer suggests a gain in allocative efficiency of 98% (i.e $1-(0.02/0.99)*100$). The frequency distribution indicated that about 24% of farmers had allocative efficiencies of 0.91-1.00 while 67% of the respondents had AE of 0.61 and above. That is, the farmers are efficient in producing pre-determined quantity of Pineapple at the minimum cost for a given level of technology.

4.8 HYPOTHESES TESTING

VISIT since you have no value of LR

The result of the stochastic frontier production function showed that farm size and labour inputs were positive and significantly related to output which implies that as the level of these inputs increase, output also increases, thus the hypothesis that there is no significant relationship between input and output is rejected.

The second hypothesis, which states that Pineapple farmers' socio-economic characteristics have no significant influence on technical and allocative efficiencies of Pineapple production, is also rejected. Hence, while farming experience, gender, extension visits, membership of cooperative societies and credit accessibility in the technical inefficiency model made significant contribution to the explanation of the technical inefficiency effects associated with the output of the farmers involved, farming experience, household size, gender, membership of cooperative societies and credit accessibility in the cost inefficiency model made significant contribution to the explanation of the cost inefficiency effects associated with the cost of production of the farmers involved in the study.

5. CONCLUSION AND RECOMMENDATION

This study used a stochastic frontier function model to estimate the economic efficiency of Pineapple production in two LGAs of Edo State, Nigeria. The analysis revealed an average level of technical, allocative and economic efficiency of 0.70, 0.68 and 0.64 respectively. None of the sampled respondents operated at the efficient level indicating that the output realized was below attainable maximum, hence there is still scope for improvement in Pineapple production in Edo State in particular and Nigeria in general. The return to scale of 0.52 suggests that the production function was characterized by decreasing returns to scale, hence Pineapple producers operated in stage II of the production surface. Results from the study indicated that adjustments in the production inputs such as farm size, increase and efficient utilization of fertilizer and labour could lead to increased production of Pineapple in the study area. Farming experience, extension contact and marital status were the socio-economic characteristics that had significant and negative effect on the farmers' technical inefficiency while gender and membership of cooperatives were observed to increase technical inefficiency. Similarly, while years of farming experience, gender, membership of cooperatives and credit accessibility were significant variables that influenced cost efficiency, household size was observed to increase cost inefficiency. Increase productivity and improvement in technical and cost efficiencies can be achieved by addressing the factors responsible for the inefficiencies.

The study recommends that policies that would focus on ways of attracting and encouraging the youths who are agile and stronger to embark on Pineapple production should be pursued such as the setting up of fruit processing factories or industries in the rural areas. Farmers in the study area should be empowered in the area of land and capital acquisition, easy accessibility to formal credit and other inputs for increase level of production. Similarly, Government agencies in the State should implement capacity building programmes to train the extension agents and farmers on Pineapple production techniques and farm management of available resources as efficient as possible to achieve optimum production.

684 Farmers should also be encouraged to setup cooperatives as well as taught the importance
 685 of being members of cooperatives as this will strengthen their role in inputs acquisition and
 686 marketing of their produce. Agricultural development programmes and policies should
 687 respect and encourage gender equity to improve accessibility to resources and transform
 688 productivity among Pineapple farmers in the study area. More research on Pineapple
 689 production should be encouraged especially in the areas of plant spacing, fertilizer
 690 application and disease control. This will solve the problem of over-crowding and infestation
 691 during the growing period.

692

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