

Application of Stochastic Frontier Function in Estimating Production Efficiency: A Dual Approach

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ABSTRACT

This study applied a dual approach to stochastic frontier model and examined the profit efficiency of castor seed producers in Nigeria. A cross sectional data of 131 randomly selected irrigated castor producers were used for the analysis. The data were estimated using MLE and OLS estimation procedures where Log likelihood test showed a strong rejection of the OLS, implying presence of production efficiency. Industry efficiency index of 0.89 suggests that castor producers fall short of frontier production point, thus, there is potential for increasing current profits without adjustments in input mix and production technology. Significant efficiency drivers identified include among others, education, extension contact, access to credit and proximity to market. Greater farmer efficiency could be attained with policies directed towards addressing these factors.

Key words: Stochastic frontier function; Duality; Profit efficiency; Castor; Nigeria

Introduction

The increasing burden of feeding the ever growing population is taking center stage in the agricultural policy frameworks of developing nations. The central focus has been increasing domestic production to meet up with the demand. Increasing the domestic production is however, bedeviled by a number of challenges the most important of which is resource constraint. This makes study of production efficiency an important factor of productivity growth in resource poor economies. The concept focuses on how current production can be improved without necessary adjustments in the input mix and production technology. This requires improving the production environment by identifying and subsequent removal of the constraints for increased production.

The stochastic frontier function is an improvement to the neoclassical approach of modeling production behaviour of firms which assumes absolute efficiency in the choice of resources. A stochastic profit frontier model takes into account random factors outside the control of farmer. This attribute addresses the noise problem characterizing deterministic frontiers where measurement errors and any other source of variation in the dependent variable are embedded in the error term (Hyuha, 2006). The basic idea lies in the introduction of an additive error term consisting of a noise and an inefficiency term. The separation of the error term into two provides more explanation of the observed inefficiency and more efficient parameter coefficients (Thiam *et al.*, 2001; Kumbhakar, 2001). Based on this, profit efficiency of castor seed farmers was analyzed by employing a dual stochastic frontier procedure with the aim of identifying farmer characteristics that explain the variations in inefficiency of individual producers.

Backgrounds on Efficiency Measurement:

There are various methods of measuring production efficiency which are generally grouped into parametric and non-parametric. The non-parametric approach uses mathematical programming techniques to estimate production frontiers. Common frontier efficiency estimation techniques in this group are data envelopment analysis (DEA) and free disposable hull analysis (FDH) (Mester, 2003). Major advantage of programming procedure is that it does not impose functional form specification on the production frontier and makes no assumption on the error term (Tran, 2009).

The procedure is however, criticized on the following drawbacks: The non-parametric methods generally ignore prices and can therefore, account only for technical inefficiency in using too many inputs or producing too few outputs (Mester, 2003); the procedure do not usually allow for random error in the data by assuming that random error is zero (Thiam *et al.*, 2001; Mester, 2003); the technique uses two-stage estimation procedure where the production (or profit) function is estimated to derive the efficiency scores in the first stage. In the second, the derived efficiency scores are specified as explanatory variables in a profit function by the methods of Ordinary Least Square (OLS) or Tobit Regression. The limitation of this exercise is that firm's knowledge of its level of technical efficiency affect its input choices, thus inefficiency may be dependent on the explanatory variables (Chirwa, 2007). Furthermore, the approach does not allow standard statistical testing procedures to

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establish a level of confidence in the inefficiency score on which production frontier can be evaluated upon (Arnade and Trueblood, 2002).

The parametric estimation procedure uses econometric techniques. Parametrical analyses of efficiency are based on the estimation of a frontier function. Since the pioneering work of Farrel (1957) in frontier and efficiency measurement, various modifications and refinements have been made. Farrel's frontier was first translated into a production function by Aigner and Chu (1968). Later on, the works of Aigner *et al.* (1977), Meeusen and van den Broeck (1977) suggested stochastic frontier, also known as composed error term. Other methods of parametric technique apart from stochastic are the thick frontier approach and the distribution free-approach. The major distinguishing feature between these three is the assumptions about the distributions of the error terms (Hyuha, 2006). The distribution-free approach for example assumes that there is a core efficiency or average efficiency over time (Mester, 2003); therefore a profit function is estimated for each period of a panel data set. This study involves cross-sectional data therefore the preference of this study is on the stochastic frontier approach of estimation which does not necessarily require panel data to accomplish.

The strength of stochastic frontier estimation technique is drawn from a number of advantages it has over programming techniques and deterministic econometric procedures. Its advantage over programming methods draws from its ability to be estimated using a single-step procedure. The parameters of the frontier production (or profit) function are simultaneously estimated with those of an inefficiency model in which inefficiency effects are specified as a function of other variables (Chirwa, 2007; Amazaet *al.*, 2006; Behr and Tente, 2008). Secondly, the approach deals with statistical test of hypotheses pertaining production structure and degree of inefficiency (Ajewole and Folayan, 2008; Arnade and Trueblood, 2002). The superiority of the stochastic frontier function over its deterministic counterpart is seen in its allowance for random error in the data. Any lower performance can be traced to random noise beyond farmers' control as well as inefficiency (Behr and Tente, 2008). The notion of a deterministic frontier ignores the possibility that a firm's performance may be affected by factors outside farmer's control. Hence, any deviation from the frontier results solely from inefficiency. The consequence is that outliers may have profound effects on the estimates and also, any shortcomings in the model specification could translate into inefficiency estimates (Hyuha, 2006). Similarly, Kumbhakar and Lovell (2000) pointed out that stochastic frontier produces efficiency estimates for individual producers, thus, it provides a powerful tool for examining the effects of intervention on individual firms.

The stochastic frontier analysis is however, not devoid of shortcomings. The procedure lacks *a priori* justification for the selection of a particular distributional form for the one sided inefficiency term (Hyuha, 2006; Chirwa, 2007). Arnade and Trueblood (2002) faulted the one- step procedure employed by stochastic frontier analysis as that which relies on computationally intensive estimation technique which cannot always distinguish between types of inefficiency. Despite these weaknesses, this study adopted the stochastic frontier procedure considering its attributes of separating the error term into two components (efficiency and noise) and its ability to report relative efficiencies of economic units in an industry. It is therefore, envisaged that the stochastic frontier analysis would provide better explanation of the observed farm-level inefficiency and more efficient parameter estimates.

There are two approaches to model production; the direct (primal) and the dual. The concept of duality provides alternative ways of expressing resource allocation problems of competitive firms. It establishes the possibility of alternative approaches to the same problems in production and consumption theory. The direct approach specifies production function to derive input demand and product supply functions. The dual on the other hand requires specifying a profit (or cost) function from which input demand and output supply functions are derived without *a priori* specification of the production function.

Applying the theory of duality, this study used profit, rather than cost function because of the observed limitations of the cost function. Lopez (1982) observed a serious limitation of the cost function approach in that it assumes output levels not to be affected by factor price change and thus, the indirect effect of factor price change on factor demand are ignored. Moreover, the inclusion of output levels as explanatory variable may lead to simultaneous equation bias if output levels are not indeed exogenous. In line with this, Mester (2003) faulted the cost function over profit function in that while the dependent variable in the cost function does not allow consideration of revenues, profit function allows for consideration of revenues that can be earned by varying output as well as inputs. Output prices are taken as exogenous allowing for inefficiency in the choice of outputs when responding to these prices.

Materials and Methods

Modelling Framework:

From the theory of production, a farmer is assumed to choose a combination of variable inputs and outputs that maximize profits subject to the underlying technology constraint. The production function can be generalized as $f(y, x, z) = 0$, where y is a vector of output, x , a vector of variable inputs, z , a vector of fixed

inputs and f is the underlying production technology. Assuming a homogeneous production technology across farms, restricted profit function can be specified thus (Kalijaran, 1985; Lopez, 1982):

$$\text{Max } p y - w x, \quad \text{s.t.} \quad f(y, x, z) = 0 \quad (1)$$

Where;

p is a vector of output prices and w is a vector of variable input prices. Given a set of inputs and outputs, the profit maximizing input demand and output supply functions are respectively expressed as:

$$X = x(p, w, z) \quad (2)$$

$$Y = y(p, w, z) \quad (3)$$

Substituting (2) and (3) into (1), derives the profit function. This is the maximum profit that a farmer can obtain given the output price p , input price w , quantity of fixed input z and the production technology $f(\cdot)$.

The profit function is expressed as:

$$\Pi = p y(p, w, z) - w x(p, w, z) \quad (4)$$

The stochastic profit frontier model:

The profit function in the presence of both technical and allocative inefficiencies is implicitly expressed as (Rahman, 2003; Hyuhaet al., 2007):

$$\Pi_i = f(P_{ij}, Z_{ik}) \cdot \exp(\epsilon_i) \quad (5)$$

Where;

Π_i = normalized profit of the i^{th} farm defined as gross revenue less variable costs divided by a farm specific price

P_{ij} = price of j^{th} variable input faced by the i^{th} farm divided by a farm specific price

Z_{ik} = level of k^{th} fixed factor used on the i^{th} farm

ϵ_i = error term

$i = 1, 2, \dots, n$ number of farms in the sample

$j = 1, 2, \dots, m$ number of variable inputs used

The error term is assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989):

$$\epsilon_i = V_i - U_i \quad (6)$$

Where;

V_i is assumed to be independently and identically distributed $N(0, \delta_v^2)$, two sided random error independent of the U_i . U_i s are non-negative random variables associated with inefficiency in production which are assumed to be independently distributed as truncations at zero of the normal distribution with mean;

$$\mu_i = \delta_0 + \sum \delta_d W_{di} \quad (7)$$

and variance δ_μ^2 ($|N(\mu, \delta_\mu^2)|$).

Where;

W_d = d^{th} explanatory variable associated with inefficiency on farm i . δ_0 and δ_d are parameters to be estimated

Individual firm efficiency score is determined as:

$$\text{Eff}_i = E[\exp(-U_i)/e_i] = E[\exp(-\delta_0 - \sum \delta_d W_{di}/e_i)] \quad (8)$$

Where, Eff_i is the efficiency of firm i relative to the best performing firm.

The Battese and Coelli (1995) procedure was used in this study by postulating a profit function which is assumed to be consistent with the concept of stochastic frontier. Earlier works in this fashion include Kumbhakar (2001), Rahman (2003), Kolawole (2006) and Okoruwaet al. (2009).

*The Data and Estimation Procedure:**The Data:*

The data used for this study were a farm level cross sectional data collected among irrigated castor seed producers in Yobe State, North-eastern Nigeria. The State is located between latitudes 9° 56' N and 13° 00' N and longitudes 9° 30' E and 12° 45' E. The survey was undertaken in the northern part of the State from where 131 castor seed producers were randomly selected. The climate of the area is tropical with four months of rains which starts from June to October with an average precipitation of 450mm per annum. Agricultural production in this part of the State is made possible during dry season because of river Yobe which traversed the length of the area. The castor, an industrial crop is promoted in the State as a means of income diversification to stem the tide of poverty pervading the largely subsistence crop producing farmers. The data consisted of quantities of output and inputs used in the 2009 production season. Revenues from castor sales are expected to improve farm earnings for the largely agrarian population. The population of the State according to national head count (NPC, 2006) was 2, 612, 971 (projected to 2012) persons. The data were analyzed using stochastic profit frontier function.

Estimation Procedure:

The Translog profit frontier function is expressed as:

$$\ln \Pi = \alpha_0 + \sum \alpha_j \ln P_j + 0.5 \sum \sum \gamma_{jk} \ln P_j \ln P_k + \sum \sum \zeta_{ji} \ln P_j \ln Z_i + \sum \beta_i \ln Z_i + 0.5 \sum \sum \theta_{it} \ln Z_i \ln Z_t + v - u \quad (9)$$

and the inefficiency model as:

$$u = \delta_0 + \sum \delta_d W_d + \omega \quad (10)$$

Where;

Π = restricted profit normalized by the price of farm power

P_{ij} = price of j^{th} variable input faced by the i^{th} farm divided by price of farm power

$j = 1$, price of output

$= 2$, price of fertilizer

$= 3$, price of chemical

$= 4$, price of seed

$= 5$, price of irrigation

Z_{ik} = level of k^{th} fixed factor on the i^{th} farm

$k = 1$, farm size (ha)

$= 2$, labour (man day)

$= 3$, depreciation on capital equipment (\square)

v = two sided random error

u = one sided half-normal error

\ln = natural logarithm

W_d = variables representing farmers' characteristics that explain inefficiency

$d = 1$, education (number of years spent in school)

$= 2$, experience (years in farming)

$= 3$, household size (number of persons)

$= 4$, non-agricultural income (available=1, not available=0)

$= 5$, extension contact (number of times in a season)

$= 6$, nearness to market (number of kilometres away)

$= 7$, access to credit (number of sources)

$= 8$, membership in cooperatives (member=1, non-member=0)

$= 9$, storage facility (available=1, not available=0)

$= 10$, soil type (upland (*Jigawa*) =1, lowland (*Fadama*) =0)

ω = two sided random error

$\alpha_0, \alpha_j, \gamma_{jk}, \zeta_{jk}, \beta_i, \theta_{it}, \delta_0$ and δ_d are parameters to be estimated.

The stochastic profit frontier and inefficiency functions specified in equations 9 and 10 were jointly estimated using FRONTIER 4.1 (Coelli, 1996). The programme combines the two-stage procedure in one. The maximum likelihood method estimates the profit function parameters and that of the inefficiency model of the

stochastic profit frontier function. A number of profit efficiency studies were done using this procedure (e.g. Rahman, 2003; Hyuhaet *al.*, 2007; Kolawole, 2006; Abdulai and Huffman, 1998).

Two estimation procedures, OLS and ML were used to establish whether or not profit efficiency is affected by farmer specific characteristics in castor seed production in the area. Given the likelihood ratio of the errors in equation 9 as:

$$\gamma = \delta_u^2 / (\delta_u^2 + \delta_v^2) \quad (11)$$

Presence of inefficiency was determined by the value of gamma (γ), its statistical significance and the generalized Log likelihood ratio test. Gamma was found to be in-between 0 and 1 indicating presence of inefficiency. The generalized Log likelihood ratio test defined by a Chi-square (χ^2) distribution set at 1% level of significance and 45 degrees of freedom was significantly different from zero. The null hypothesis was thus rejected indicating that the Translog rather than the Cobb-Douglas form fits the data.

Results and Discussion

The Structure of Castor Seed Production:

Analysis of results (Table 1) show the first order explanatory variables to have the expected signs and statistically significant ($p < 0.01$) except the coefficient on irrigation variable. The results suggest that short-run profit in irrigated castor seed production is positively influenced by castor price. In line with this, profits could be increased when producer price of the crop is increased *ceteris paribus*. Similarly, profits could be increased when inputs prices such as fertilizers, chemical and seeds are reduced. The signs of the fixed inputs were also consistent and statistically significant ($p < 0.01$). The significance of the coefficients of land and family labour indicates that their increases could increase short-run profits while decrease in depreciation of capital assets increase profits.

The ML estimates generated by the stochastic profit frontier function in Table 1 is compared with OLS results (Table 2). Apart from the coefficient of price of castor, all other variables were not statistically significant. The sign on the coefficient of seed was found bear positive sign contrary to the expected sign. In line with this researchers (Kumbhakar, 2001; Arnade and Trueblood, 2002; Abrar, 2003) cautioned the use of models that do not incorporate inefficiency in modelling agricultural production. For instance Abrar (2003) reported own-price elasticity of 0.21 and 0.52 respectively for standard model and the one that incorporates inefficiency, indicating a wide variation between the two results.

In this study, the value of gamma (γ) was found to be less than 1 and statistically different from zero ($p < 0.01$) indicating presence of inefficiency. The system of log likelihood ratio test used to ascertain the appropriate form that fits the data was rejected in favour of translog (Table 3). This implies that variation in profits between individual firms is stochastic rather than random. Thus, variation occurs both as a result of farmer inefficiency and effects of exogenous factors outside the control of the farmer.

Estimation of Profit Efficiency:

Estimates of individual inefficiencies of the castor seed farmers are presented in Table 4. The mean inefficiency score was 0.89 indicating that about 11% profits are lost due to both technical and allocative inefficiency. It also means that current profit could be increased by about 11% without necessary adjustments in the current input mix and the existing production technology. The mean efficiency score suggests that castor farmers exhibit a high level of profit efficiency; however, there also exist a wide variation of profit inefficiency among individual firms. The variation ranges from a minimum of 0.42 to a maximum of 1.0 but the variation is rather skewed to the right with 92.4% of the farmers attaining profit efficiency scores of between 0.71 and 1.0.

Determinants of Profit Inefficiency:

Analysis of farmer efficiency drivers in Table 5 indicates that the coefficient on education was negative and significant. This indicates that profit inefficiency decrease with increase in years of schooling. Education therefore, reduces profit inefficiency in castor production. A negative and significant coefficient of experience indicates decrease in profit inefficiency with increase in farming experience among irrigated castor farmers. Household size was positive and statistically significant at 10% suggesting that household size increases profit inefficiency.

Table 1: Maximum Likelihood Estimates of the Translog Profit Frontier Function for Operators of Irrigated Castor Farms

Variables	Parameter	Coefficient	t-ratio	Variables	Parameter	Coefficient	t-ratio
Constant	α_0	-7.524	-6.784***	$\ln Pf \times \ln Z_2$	ζ_{32}	-0.377	-1.238
$\ln Pc$	α_1	5.148	5.492***	$\ln Pf \times \ln Z_3$	ζ_{23}	-0.036	-0.829
$\ln Pf$	α_2	-0.423	-3.612***	$\ln Pch \times \ln Z_1$	ζ_{31}	0.907	1.401
$\ln Pch$	α_3	-0.616	-6.004***	$\ln Pch \times \ln Z_2$	ζ_{32}	0.115	0.568
$\ln Ps$	α_4	-0.261	-26.219***	$\ln Pch \times \ln Z_3$	ζ_{33}	0.176	1.139
$\ln Pi$	α_5	-0.372	-0.391	$\ln Ps \times \ln Z_1$	ζ_{41}	-0.549	-0.799
$1/2 \ln Pc \times \ln Pc$	γ_{11}	-0.173	-0.861	$\ln Ps \times \ln Z_2$	ζ_{42}	1.151	1.407
$1/2 \ln Pf \times \ln Pf$	γ_{22}	-0.324	-0.652	$\ln Ps \times \ln Z_3$	ζ_{43}	0.294	0.298
$1/2 \ln Pch \times \ln Pch$	γ_{33}	-4.074	-3.948***	$\ln Pi \times \ln Z_1$	ζ_{51}	28.568	27.842***
$1/2 \ln Ps \times \ln Ps$	γ_{44}	309.494	309.402***	$\ln Pi \times \ln Z_2$	ζ_{52}	-0.338	-0.389
$1/2 \ln Pi \times \ln Pi$	γ_{55}	-0.220	-0.719	$\ln Pi \times \ln Z_3$	ζ_{53}	-1.067	-2.453**
$\ln Pc \times \ln Pf$	γ_{12}	-0.611	-1.450	$\ln Z_1$	β_1	1.502	2.973***
$\ln Pc \times \ln Pch$	γ_{13}	-0.914	-1.413	$\ln Z_2$	β_2	2.281	2.752***
$\ln Pc \times \ln Ps$	γ_{14}	-3.692	-3.534***	$\ln Z_3$	β_3	-19.734	-20.761***
$\ln Pc \times \ln Pi$	γ_{15}	1.947	3.405***	$1/2 \ln Z_1 \times \ln Z_1$	ω_{11}	-1.419	-2.640***
$\ln Pf \times \ln Pch$	γ_{23}	4.403	4.750***	$1/2 \ln Z_2 \times \ln Z_2$	ω_{22}	-0.117	-0.863
$\ln Pf \times \ln Ps$	γ_{24}	-16.276	-14.656***	$1/2 \ln Z_3 \times \ln Z_3$	ω_{33}	0.168	0.859
$\ln Pf \times \ln Pi$	γ_{25}	-1.832	-2.252**	$\ln Z_1 \times \ln Z_2$	ω_{12}	-0.383	-1.338
$\ln Pch \times \ln Ps$	γ_{34}	-29.381	-29.015***	$\ln Z_1 \times \ln Z_3$	ω_{13}	3.927	5.417***
$\ln Pch \times \ln Pi$	γ_{35}	2.017	2.252**	$\ln Z_2 \times \ln Z_3$	ω_{23}	0.095	0.534
$\ln Ps \times \ln Pi$	γ_{45}	10.437	10.270***				
$\ln Pc \times \ln Z_1$	ζ_{11}	-2.922	-2.746***				
$\ln Pc \times \ln Z_2$	ζ_{12}	2.938	2.708***				
$\ln Pc \times \ln Z_3$	ζ_{13}	-0.083	0.155				
$\ln Pf \times \ln Z_1$	ζ_{21}	-1.031	-1.111				

***Significant at 1% **Significant at 5%

Table 2: OLS Estimates of the Profit Function for Irrigated Farm Operators

Parameter	Coefficient	t-ratio
Constant	-6.672	-1.631
$\ln Pc$	1.493	2.812***
$\ln Pf$	-2.533	-1.031
$\ln Pch$	-6.606	-1.115
$\ln Ps$	26.175	0.358
$\ln Pi$	-0.311	-0.097
Z_1	0.930	1.208
Z_2	2.543	1.442
Z_3	-19.636	-0.818
***Significant at 1%		

Table 3: Log Likelihood Ratio Test

	OLS		MLE
LL	-48.36		-28.48
LLR		39.72	
χ^2 -Value		29.7	
Decision		Reject	

Table 4: Profit Efficiency Estimates for Castor Seed Farmers

Efficiency	Frequency	Percentage
<0.20	0	0
0.20-0.30	0	0
0.31-0.40	0	0
0.41-0.50	1	0.76
0.51-0.60	2	1.53
0.61-0.70	7	5.34
0.71-0.80	15	11.45
0.81-0.90	24	18.32
0.91-1.0	82	62.6
Total	131	100
Mean	0.89	
Min	0.42	
Max	1.0	

Extension contact was positive and significant among irrigated castor farmers. This result was not consistent with expectation. It suggests that profit inefficiency increases with increase in extension contact. Possible reason for this finding could be associated with the quality of extension service dissemination to farmers in the study area. Frequent visit is adjudged (Idrisa, 2009; Ouma *et al.*, 2006) the measure of extension

quality. In this study, extension contact was measured as number of visits which was poor especially to irrigated farmers where average of only two visits was paid. It was observed that majority of castor farmers were at most visited twice; hence a good number of farmers did not have adequate extension contact during the period. For the few that had contact, information acquired may not be timely in accordance with farmers' current need considering the fact that proper guidance will be required at every level of crop development since the crop is new to the farmers. The combination of these anomalies could be responsible for the unexpected sign on the coefficient.

Table 5: Determinants of Profit Inefficiency among Irrigated Castor Farmers

Variables	Parameter	Coefficient	t-ratio
Constant	δ_0	4.904	3.424**
Education	δ_1	-0.246	-2.676***
Experience	δ_2	-0.079	-2.333**
Household size	δ_3	0.098	2.107*
Non-agric income	δ_4	1.503	1.498
Extension contact	δ_5	0.707	2.709***
Nearness to market	δ_6	-0.103	2.900***
Access to credit	δ_7	-3.753	-2.961***
Membership in coop.	δ_8	0.737	0.782
Storage facility	δ_9	-4.358	-3.225***
Soil type	δ_{10}	2.05	2.302**

*** Significant at 1% ** Significant at 5% *Significant at 10%

Nearness to market was negative and significant, suggesting that profit inefficiency decreases when distance between farms and markets decreases. This implies that profit efficiency in castor farming could be enhanced by proximity of farms to markets.

Coefficient on access to credit was negative and significant. This means that credit availability increases profit efficiency among irrigated castor farmers. Alternatives to credit sources at the disposal of farmers could afford them to access funds to purchase high technology farm inputs that could lead to reduction in inefficiency.

Coefficient of storage facility was negative and statistically significant. This means that availability of storage facility reduces profit inefficiency among irrigated castor farmers. This is consistent with expectation, that farmers with storage facility could hold back their harvest until when favourable producer price is offered. However, in this study given that farmers sell to a single buyer, such conclusion should be drawn with caution. Possible explanation to this contradiction is that the study only sought to know whether farmers had storage facilities without being specific on whether such facilities were used for castor storage. It was observed that in most places where irrigation was practiced, farmers were disposed to having storage facilities where inputs (e.g. fertilizers, etc.), products (e.g. dried pepper, etc.), water pumps and their accessories were kept. The relevance of this to this study is that proper storage of these important farm items could guarantee their effective performance and hence the farmers' efficiency.

Soil type coefficient was positive and significant. This implies that profit inefficiency increases where farms are located on *fadama* soils than on flat lands.

Conclusion and Policy Implications:

This paper applied a stochastic translog profit frontier model to data on castor seed production in Nigeria. The profit model suggests that short-run profits could be increased through reduction and increases in inputs and output prices respectively, implying that policies to improve farm profit should be directed at enhancing producer prices as well as ways to reduce prices of inputs.

The study also showed that presence of inefficiency could lead to misleading conclusions when models that assume absolute efficiency are used to model production. This was indicated by the Log likelihood test which rejected the model without inefficiency in favour of the one that incorporates inefficiency.

Production efficiency analysis showed that castor seed producers have high mean efficiency, however, the efficiency varied among firms. The mean efficiency of 0.89 suggests that farmers could increase short-run profits by about 11% which is the proportion of profit loss due a combination of technical and allocative inefficiency.

The findings suggest significant efficiency drivers to include among others, education, extension contact, proximity to market, access to credit and availability of storage facility. This indicates that policy that ensures education of farmers is an important factor in the development of agriculture in Nigeria. Furthermore, access to credit and nearness to market were found to enhance production efficiency. Therefore strategies to improve agricultural productivity should focus on improved farmer access to institutional credits and improved infrastructural facilities such as access roads for easy linkage to markets.

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