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Profit Efficiency in Castor Seed Production: Analysis of Rain fed and Irrigated Systems

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Abstract

Efficiency literature reported that production efficiency differed among farmers within and between crop enterprises and even between geographical locations, thus necessitating specific polices for specific situations. In this study, profit efficiency of rain fed and irrigated castor seed producers were determined and compared using stochastic profit frontier function. Rain fed and irrigation farmers Yobe state were the research subjects. The samples consisting of 172 and 131 rain fed and irrigation farmers respectively, were drawn using simple random sampling. Results of the study revealed that both production systems fall short of earning frontier profit in their production processes. Average profit efficiency scores of 0.76 and 0.89, respectively for rain fed and irrigated farm operators suggest that both were not operating on the profit frontier suggesting that current profits could be increased by about 24% and 11%, respectively. Efficiency drivers identified include education, credit and extension. The study concluded that profit inefficiency also exist among castor seed producers on one hand and on the other, there are differentials in

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efficiency between rain fed and irrigated castor farm operators. Furthermore, efficiency factors were found to be similar at one point and different in another indicating that profitability improvement in the castor industry too should have specific policy approaches as suggested by the efficiency determinants.

Key Words: Profit Efficiency; Stochastic Profit Frontier Function; Castor Seed; Rain fed; Irrigation; Nigeria.

Introduction

Efficiency studies play crucial roles in the development of developing economies where production resources are a major impediment. Thus efficiency studies are important guidance for policy formulation. The importance of efficiency study draws from the concept's ability of providing ways of benchmarking firms' relative performance (Berger and Humphrey, 1997). This important role aroused the interests of researchers and policy makers leading to vast literature worldwide (e.g. Ali and Chaudry, 1990; Amaza and Olayemi, 2002; Hyuha *et al.*, 2007).

There are two ways of measuring production efficiency; the parametric and non-parametric frontier techniques. The parametric frontier is further categorized into primal and dual methods. While the former received wider acknowledgement in the efficiency literature in Nigeria, the latter lags far behind (Ogundari *et al.*, 2010). The dual involves specifying a profit or a cost function where knowledge of prices is important as opposed to the production function that only requires physical quantities of resources employed, neglecting the roles of prices. In this study, the profit rather than cost function was used because of the observed limitation that the cost function exhibits. Lopez (1982) observed the assumption of the cost function of output levels to be independent of factor price change as a serious limitation.

Several studies (e.g. Okoruwa *et al.*, 2009; Amaza and Olayemi, 2002; Rahman, 2003) revealed that efficiency differed among farms, crop types and enterprises. Evidence also exists of varying degrees of efficiency among farmers in the six geopolitical zones of Nigeria (Ogundari *et al.*, 2010) suggesting that improvement in the efficiency and productivity of the agricultural sector requires specific policies within and between the various sub groups in the sector.

It is against this backdrop that this study sets out to examine the profit efficiency of rain fed and irrigated castor farm operators with a view to identify farmer characteristics that explain variation in the individual farmer efficiency among the two production systems. This will highlight specific areas where intervention would be required to increase efficiency and productivity of the agricultural sector in general and the castor seed sub sector in particular.

The outline of the paper is organized as follows: Section 2 highlights the modelling framework; section 3 provides the description of the data and empirical model. While section 4 discusses the findings, section 5 concludes the paper.

2 Modelling Framework

Production efficiency is an all encompassing term consisting of the technical and allocative efficiencies. While technical efficiency is defined as the ability of a firm to produce maximum feasible output from a giving quantity of inputs, its allocative counterpart is defined as the ability to combine inputs in optimal proportions given the observed input prices (Coelli *et al.*, 2002). Production inefficiency therefore, refers to failure of a firm to produce the maximum output from a giving input mix and failure to equate marginal returns of factor inputs to their prices. Estimation of frontier production efficiency could be accomplished through either of the two approaches; deterministic, where all deviations from the frontier are attributed to inefficiency and stochastic which discriminate between random errors and inefficiency (Rahman, 2003). A stochastic frontier function takes into account random factors outside the control of farmer, thus addressing the noise problem of deterministic frontier which assumes any other source of variation to be embedded in the error term (Hyuha *et al.*, 2007). The separation of the error term into noise and inefficiency provides more explanation of the observed inefficiency and more efficient parameter coefficients (Thiam *et al.*, 2001; Kumbhakar, 2001).

Battesse and Coelli (1995) extended the stochastic frontier production model by suggesting that the inefficiency effect can be expressed as a linear function of explanatory variables reflecting farm specific characteristics. This procedure has the advantage of estimating farm specific efficiency scores and the factors explaining efficiency differentials among farmers in a single stage. This study adopted the Battesse and Coelli (1995) model 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 Okoruwa *et al.* (2009).

The stochastic profit frontier model

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

$$\Pi_i = f\,(P_{ij}, Z_{ik})\ .\ \exp\,(\varepsilon_i) \quad \text{.......} \quad (1)$$

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

e_i = error term

i = 1,2,……,n number of farms in the sample

j = 1,2,…….,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):

$$\varepsilon_i = V_i - U_i \quad \text{.......} \quad (2)$$

Where;

V_i is assumed to be independently and identically distributed

$N(0, \delta^2_v)$, two sided random error independent of the U_i. U_{is} 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;

$$\mu_i = \delta_0 + \Sigma \delta_d W_{di} \quad \text{...} (3)$$

and variance $\delta^2_\mu (|N(\mu, \delta^2_\mu)|)$.

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:

$$Eff_i = E[\exp(-U_i)/e_i] = E[\exp(-\delta_0 - \Sigma \delta_d w_{di}/e_i] \quad \text{..............................} (4)$$

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

3 Descriptions of Data and Empirical Model

The Data

The study employed primary data collected from a survey of castor seed producers in Yobe State North-eastern Nigeria. The State is located between latitudes 9^0 56' N and 13^0 00' N and longitudes 9^0 30' E and 12^0 45' E. The climate of the area is tropical with four months of rains which starts from June to October at an average of 450mm and 750mm per annum in the northern and southern parts of the State, respectively. The survey was undertaken in the 17 Local Government Areas (LGAs) of the State. Rain fed and irrigated production systems were employed in the southern and northern parts of the State, respectively. A cross section of 172 rain fed and 131 irrigated castor farm operators were randomly selected.

The Empirical Model

The translog profit frontier function is expressed as:

$$\ln \Pi = \alpha_0 + \Sigma \alpha_j \ln P_j + 0.5 \Sigma \Sigma \gamma_{jk} \ln P_j \ln P_j + \Sigma \Sigma \zeta_{jl} \ln P_j \ln Z_l + \Sigma \beta_l \ln Z_l + 0.5 \Sigma \Sigma \theta_{lt} \ln Z_l \ln Z_l + v - u \quad \text{..} (5)$$

and the inefficiency model as:

$u = \delta_0 + \Sigma \delta_d W_d + \omega$ .... (6)

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 flow (applies only to irrigated production) (□)

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 (⊟)
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 from farm)
= 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

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

The stochastic profit frontier and inefficiency functions specified in equations 5 and 6 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. Abdulai and Huffman, 1998; Rahman, 2003; Kolawole, 2006; Hyuha *et al.*, 2007).

4. Results and Discussion

Profit Efficiency in Castor Seed Production

The efficiency scores of individual farmers and average efficiencies of rain fed and irrigated castor farms were estimated from the efficiency function given by equation 6. The results are presented in Table 1.

The results show average efficiency scores of 0.76 and 0.89 for rain fed and irrigated castor farm operators, respectively. This indicates that castor farmers in the study area exhibit different levels of profit efficiency with irrigated farmers showing higher average performance in relation to their rain fed counterparts. The mean efficiency scores suggest that about 24% and 11% profits are lost by rain fed and irrigated castor farmers, respectively due to presence of both technical and allocative inefficiencies. In other words, potential exists for rain fed and irrigated castor farmers to increase current profits by 24% and 11%, respectively without adjustment in current input mix and production technology.

In both production systems, farmers exhibit a wide range of profit efficiency ranging from a minimum of 0.03 to a maximum of 0.99 among rain fed and a minimum of 0.42 to a maximum of 1.0 among irrigated farm operators. Wide variation in inefficiency among farmers is not peculiar to castor seed farmers. Similar results were observed among food crop farmers and in poultry production (Amaza and Olayemi, 2002; Kolawole, 2006; Tijani *et al.*, 2006).

Table 1: Profit Efficiency Estimates for Castor Seed Farmers

	Rain fed		Irrigated	
Efficiency	**Frequency**	**Percentage**	**Frequency**	**Percentage**
<0.20	2	1.16	0	0
0.20-0.30	4	2.33	0	0
0.31-0.40	9	5.23	0	0
0.41-0.50	9	5.23	1	0.76
0.51-0.60	11	6.4	2	1.53
0.61-0.70	14	8.14	7	5.34
0.71-0.80	32	18.6	15	11.45
0.81-0.90	39	22.67	24	18.32
0.91-1.0	52	30.23	82	62.6
Total	**172**	**100**	**131**	**100**
Mean	**0.76**		**0.89**	
Min	**0.03**		**0.42**	
Max	**0.99**		**1**	

It could be deducted from the Table, about 71.5% and 92.4% of rain fed and irrigated farm operators, respectively have attained profit efficiency scores of between 0.71 and 1.00. This indicates the castor industry's general performance. The paired t-statistic set at 1% critical value was greater than the observed t-value. Thus, irrigated castor farmers were more profit efficient than rain fed farmers and that this disparity was as a result of the identified significant factors in their respective inefficiency models.

Analysis of individual farm's efficiency revealed that while about 9% of rain fed farmers showed dismal efficiency scores of between 0.0 and 0.4, none of the irrigated farm operators was found to operate in this category. Furthermore, about 8% of irrigated farm operators were found to attain scores of between 0.41 and 0.7, indicating that 92% of the irrigated farm operators had efficiency scores of between 0.7 and 1.0. On a general note, the result showed that most of the farmers (both rain fed and irrigated farm operators) exhibited high level (usually more than 0.5) of profit efficiency.

Determinants of Profit Inefficiency in Castor Seed Production

The Maximum Likelihood (ML) estimates of the translog profit frontier function jointly estimated parameters of the profit and inefficiency functions specified by equations 5 and 6. The estimated values of gamma (γ) in both production systems are close to one and significantly different from zero ($p<0.01$) indicating that variation in actual profit from frontier profit is stochastic rather than random suggesting the presence of a mixture of profit inefficiency and statistical noise. This justifies the use of stochastic rather that a deterministic model that interprets any deviation from the frontier simply as inefficiency.

Profit inefficiency among rain fed castor farmers

The ML estimates of the inefficiency function for rain fed castor farmers defined by equation 6 is presented in Table 2. The results show level of education measured in years spent in school to have significant impact in reducing profit inefficiency among rain fed castor farmers. The sign on the coefficient indicates that higher education levels reduce inefficiency. This finding is consistent with Amaza and Olayemi (2002), Tijani *et al.* (2006) and Effiong and Onyenwaku (2006) whose findings show reduction in inefficiency with education level among Nigerian farmers. Similarly, education showed significant effect in enhancing farmer efficiency across the globe (e.g. Stefanou and Sexena, 1988; Abdulai and Huffman, 1998; Hyuha *et al.*, 2007; Alene *et al.*, 2008). The underlying assumption is that education level of the central decision unit of the household could pave way for acceptance of new ideas and taking decisive action for positive change.

The coefficient of experience was negative consistent with expectation and statistically significant ($p<0.01$). The negative sign indicates that profit inefficiency decreases with experience. Though castor farming is new in the study area, this study considered farmers' experience in general farming. It was hypothesized that experience in farming acquired over the years will significantly influence castor farming as well. Thus, castor production is assumed to be an additional crop enterprise being introduced into the existing farm enterprises. Farmers with more years of experience are likely to be more efficient in resource allocation and utilization. Experience was also found to significantly reduce profit inefficiency among rice farmers (Abdulai and Huffman, 1998; Rahman, 2003; Kolawole, 2006). Similarly, Ogunniyi (2008) found negative and significant relationship between profit inefficiency and experience among cocoyam farmers in south-western Nigeria.

Table 2: Determinants of Profit Inefficiency of Operators of Rain fed Castor Farms

Variables	Parameter	Coefficient	t-ratio
Constant	δ_0	-6.140	-7.192***
Education	δ_1	-0.054	-4.646***
Experience	δ_2	-0.035	-8.013***
Household size	δ_3	-0.010	-2.300**
Non-agric. Income	δ_4	-0.892	-5.783***
Extension contact	δ_5	-0.038	-0.197
Nearness to market	δ_6	-0.048	-3.962***
Access to credit	δ_7	-1.103	-4.441***
Membership in cop	δ_8	-0.549	-2.604***
Storage facility	δ_9	2.797	2.986***
Soil type	δ_{10}	1.325	4.555***

Source: Field Survey, 2010. **** Significant at 1% ** Significant at 5%*

The coefficient of household size was negative and statistically significant; this shows that profit inefficiency decreases with increase in the size of households. This agrees with the findings of Nwachukwu and Onyenwaku (2007). Household size to some extent explains the level of labour availability of farming households. The tendency is that families with large members could assign responsibilities for effective crop management. This could be true when more days of labour are required for the additional task brought about by the introduction of castor crop into the existing enterprises.

Non-agricultural income was negative and statistically significant. This is in line with the findings of Abdulai and Huffman (1998) and Rahman (2003). In this study, this was however, not *a priori* expected. The expectation was that availability of non-agricultural income sources would increase profit inefficiency because farmers' time would be allocated among chain of economic activities they engage in, thus contributing to inefficiency in castor production. The implication of this finding therefore is that availability of non-agricultural income explains the tendency of rain fed castor farmers devoting extra resources sought from occupations other than agriculture into castor production. This could be in terms of procurement of improved productive inputs.

A negative non-significant relationship was found between extension contact and profit inefficiency among rain fed castor farmers. This result is in line with the findings of Rahman (2003) and Nwachukwu and Onyenwaku (2007). Extension contact is expected to disseminate information on modern technology to farmers with the aim of enhancing their livelihoods. It was therefore expected that such contacts would increase the profit efficiency of rain fed castor farmers in line with Hyuha *et al.* (2007) where significant relationship exists between extension contact and profit inefficiency among rice farmers in Uganda.

Nearness to market was found to be significant ($p<0.01$) and relate negatively with profit inefficiency. This suggests that the closer the market is located to point of castor production, the lower the level of profit inefficiency. Market in this analysis refers to input and product markets. The closer the point of input purchase and product disposal is to the farm, the higher the level of profit efficiency. The implication of this finding is that farmers can be more profit efficient with reduced cost of transaction such as in handling, transportation and so on. Reduced cost of transaction increases profit *ceteris paribus*. When farms are located within the vicinity of markets, timely delivery of productive inputs could be guaranteed and this may consequently enhance farmers' profit efficiency.

The coefficient of access to credit was significant and negatively relates with profit inefficiency. This finding suggests that profit efficiency can be increased with availability of credit. Availability of credit is likely to empower farmers to afford high quality inputs in their production activities and consequently increase yield per hectare. Access to credit was found to increase profit efficiency in both crops and livestock production (Abdulai and Huffman 1998; Hyuha *et al.*, 2007; Tijani *et al.*, 2006; Ogunniyi, 2008).

Membership in cooperatives has significant effect on profit inefficiency of rain fed castor farmers. The negative and significant ($p<0.01$) coefficient indicates that increased involvement in cooperative associations reduces profit inefficiency. Farmers' involvement in cooperative activities is expected to increase their exposure to new ideas. Their coming together is also likely to make them benefit from scale economies in terms of input access and sales of output. This will consequently have positive effects on the farmers' way of doing things including castor seed production practices. Membership in cooperatives was also found to reduce profit inefficiency among rice farmers in south-eastern Nigeria (Nwachukwu and Onyenwaku, 2007).

The coefficient of storage facility was positive and statistically significant. This was however, not expected. It was envisaged that farmers with storage facilities at their disposal may be more profit efficient because they can keep their harvests for good future market. The findings here however, indicate that farmers' profit inefficiency tends to increase when they have storage facilities. But the castor farmers were into agreement that their produce would only be sold to a processing concern. This condition of selling to a sole buyer may justify the positive sign on the coefficient. By the regulated product market, output prices were determined and agreed upon by the parties involved at the beginning of the season. Therefore, whether or not produce stay long, selling price does not change.

The coefficient of soil type was positive and significant. This indicates that profit inefficiency increases when farms are located in flood plains (*fadama*). This result was also contrary to expectation. The reason for this contradiction could be ascribed to nutritional response of castor to soil types meaning that no glaring difference in castor yields could be observed between production in *fadama* and upland farms. A justification to this claim could be found when relative individual efficiencies of *fadama* and upland farms are considered. Somewhat similar individual efficiencies were observed between *fadama* and upland farms in this study.

Profit inefficiency among irrigated castor farm operators

Farmer specific factors that affect profit inefficiency among irrigated castor farm operators are presented in Table 3. The coefficient of education was negative and significant. This indicates that profit inefficiency decrease with increase in years of schooling. This is in line with what obtained among rain fed castor farmers. Education therefore, reduces profit inefficiency in both farmer categories under this study. A negative and significant coefficient of experience indicates decrease in profit inefficiency with increase in farming experience among irrigated castor farmers. Experience was also found to be significant in reducing profit inefficiency among rain fed castor farmers. The implication is that notwithstanding the production system employed, experience reduces inefficiency in castor production.

Household size was positive and statistically significant ($p<0.1$). Household size coefficient was however, found to be negative and significant ($p<0.05$) among rain fed farmers. This finding suggests that while household size affects profit inefficiency under rain fed, its effects were inconsequential among irrigated farmers. This could be explained by the quality of labour involved in the two production systems. It was observed that the rain fed farmers were less enthusiastic to the kind and quality of labour supplied by the household members on the farm. Virtually every member of a household including women and children were disposed to performing any task on the farm. Contrary to this was observed in irrigated farming communities. Some level of professionalism was attached to different tasks on the farm such that not every member is disposed to every task. This may be the reason why rather than quantity of available labour, its quality was the concern under irrigation. In line with this, household size was found to be not statistically significant in poultry egg (Tijani *et al.*, 2006) and milk (Nganga *et al.*, 2010) production enterprises.

Table 3: 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_5	1.503	1.498
Extension contact	δ_6	0.707	2.709***
Nearness to market	δ_7	-0.103	2.900***
Access to credit	δ_8	-3.753	-2.961***
Membership in coop.	δ_9	0.737	0.782
Storage facility	δ_{10}	-4.358	-3.225***
Soil type	δ_{11}	2.05	2.302**

Source: Field Survey, 2010.
**** Significant at 1% ** Significant at 5% *Significant at 10%*

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 during the season under study. 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 it is new to the farmers. The combination of these anomalies could be responsible for the unexpected sign on the coefficient.

Nearness to market was negative and significant, suggesting that profit inefficiency decreases when distance between farms and markets decreases. The coefficient of this variable was also negative and statistically significant under rain fed. This implies that profit efficiency in castor farming could be enhanced by proximity of farms to markets or by having facilities that link farms to markets such as good roads.

Coefficient on access to credit was negative and significant. This means that credit availability increases profit efficiency among irrigated castor farmers. This finding is similar to what obtained under rain fed. Different alternative credit sources at the disposal of farmers afford them to access funds to purchase high quality farm inputs that could lead to reduction in inefficiency.

Membership in cooperatives was positive and not statistically significant. The expectation was that membership of cooperatives will reduce profit inefficiency. However, this finding indicates that membership in cooperatives did not have effects on profit efficiency among irrigated castor farm operators. A negative and significant relationship was however, found between profit inefficiency and membership of cooperatives among rain fed farmers. The source of this variation may stem from the fact that ordinary membership in cooperatives was considered instead of level of farmers' involvement in the programmes and activities of the cooperatives. The tendency is that a person could just be a 'passive' member of a cooperative association and by this may fail to benefit from association's activities that could enhance his capability. The implication of this finding is that there may be presence of a good number of passive association members among irrigated castor farmers that warrants this revelation.

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. This coefficient though statistically significant but had a positive sign under rain fed. However, given that both farmer categories sell to a common 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 but 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 as in rain fed system. This implies that profit inefficiency increases where farms are located on *fadama* soils both under rain fed and irrigation systems.

5. Conclusion and Policy Implications

The findings of this study revealed that both rain fed and irrigated farms exhibit varying levels of profit inefficiency that average between 0.24 and 0.11 respectively. Thus, both farms were not operating at the profit frontier due to profit inefficiency. Hence, considerable profits could be rescued under both production systems without necessarily changing the present input structure and the underlying production technology.

Factors associated with these inefficiencies were socioeconomic, institutional and environmental, including education, credit and market infrastructure. Considerable amount of profits could therefore be recovered when these inefficiency drivers are properly addressed. On the whole, there are marked similarities as well as differences among the two farmer groups under study. Hence, efforts at improving castor production in the two farming groups should have to be system-bound as the study found varying efficiency determinants between the groups.

The policy implications are that profit inefficiency could be reduced when measures that ensure farmer education, credit access and facilities that guarantee easy access to markets are observed. The findings of this study show that all the farmers involved in the castor production programme were males. Including female farmers will ensure gender balance and since the bottom line of the programme is enhancing farmers' welfare through production of high value crops, including female farmers would reduce their vulnerability.

References

Abdulai, A. and Huffman, W. E. (1998). An Examination of Profit Inefficiency of Rice Farmers in Northern Ghana. Staff Paper No. 296 Department of Agricultural Economics, Iowa State University, Ames I A 50011. 27P.

Alene, A.D., Manyong, V.M., Omunya, G.O Mignouna, H.D., Bokanga, M. and Odhiambo, G.D. (2008). Economic Efficiency and Supply Response of Women Farm Managers: Comparative Evidence From Western Kenya. *World Development,* 36(7): 1247-1260.

Ali, M. and Chaudry, M.A. (1990). Inter-regional Farm Efficiency in Pakistan's Punjab: A Frontier Production Function Study. *Journal of Agricultural Economics,* 41: 62-74.

Amaza, P.S. and Olayemi, J.K. (2002). Analysis of Technical Inefficiency in Food Crop Production in Gombe State, Nigeria. *Journal of Applied Economic Letters,* 9: 405-411.

Battesse, G. and Coelli, T. (1995). A Model for Technical Inefficiency effects in a Stochastic Frontier Production Functions for Panel Data. *Empirical Economics* 20:325-332.

Berger, A. and Humphrey, D.B. (1997). Efficiency of Financial

Institutions: International Survey and Directions for Future Research. *European Journal of Optional Research,* 98: 175-212.

Coelli, T.J. (1996). A Guide to Frontier Version 4.1c. A Computer programme, Frontier Production and Cost Function Estimation. Department of Econometrics, University of New England, Armidale.

Coelli, T., Rahman, S. and Thirtle, C. (2002). Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-Parametric Approach. *Journal of Agricultural Economics,* 53: 607-626.

Effiong, E.O and Onyenwaku, C.E. (2006). Profit Efficiency in Broiler Production in Akwa Ibom State, Nigeria. *International Journal of Agriculture and Rural Development,* 7(1): 72-79.

Hyuha, T.S., Bashaasha, B., Nkonya, E. and Kraybill, D. (2007). Analysis of Profit Efficiency in Rice Production in Eastern and Northern Uganda. *African Crop Services Journal,* 15(4): 243-253.

Idrisa, Y.L. (2009). Analysis of Determinants of Soybean Production Technology by Farmers in Southern Borno, Nigeria. Unpublished Ph.D. Thesis Department of Agricultural Economics and Extension Services University of Maiduguri, Maiduguri, Nigeria. 122P.

Kolawole, O. (2006). Determinants of Profit Efficiency among Small Scale Rice Farmers in Nigeria: A Profit Function Approach. Poster Paper Prepared for Presentation at the International Association of Agricultural Economists Conference Gold Coast, Australia.

Kumbhakar, S.C. (2001). Estimation of Profit Functions When Profit is Not Maximum. *American Journal of Agricultural Economics,* 83(1): 1-19.

Lopez, R.E. (1982). Applications of Duality Theory to Agriculture. *Western Journal of Agricultural Economics,* 21: 353-365.

Nganga, S.K., Kungu, J. de Ridder, N. and Herero, M. (2010). Profit Efficiency Among Kenyan Smallholder Milk Producers: A Case Study of Meru-south District, Kenya. *African Journal* *of Agricultural Research,* 5(4): 332-337.

Nwachukwu, I.N. and Onyenwaku, C.E. (2007). Economic Efficiency of Fadama Telfairia Production in Imo State, Nigeria: A Translog Profit Function Approach. http://mpra.ub.uni-muenchen.de/13469/1/eco efficiency pdf. Retrieved 10/7/10.

Ogundari, K., Amos, T.T. Ogundari, I.O. and Okoruwa, V.O. (2010). A Review of Agricultural Production Efficiency Literature, 1999-2010: What Does One Learn from Frontier Studies? 32P.

Ogunniyi, L.T. (2008). Profit Efficiency among Cocoyam Producers in Osun State, Nigeria. *International Journal of Agricultural Economics and Rural Development,* 1(1):38-46.

Okoruwa, V.O., Akindeinde, A.O. and Salimonu, K.K. (2009). Relative Economic Efficiency of Farms in Rice Production: A Profit Function Approach in North Central Nigeria. *Tropical and Subtropical Agro ecosystems,* 10(2): 279-286.

Ouma, J.O., De Groot, H. and Owuor, G. (2006). Determinants of Improved Maize seed and Fertilizer use in Kenya: Policy Implication. Paper Presented at the International Association of Agricultural Economists' Conference, Gold Coast, Australia, August. 12-18.

Rahman, S. (2003). Profit Efficiency among Bangladeshi Rice Farmers. Proceedings of th 25th International Conference of Agricultural Economists (IAAE) 16-22 August, Durban, South Africa. 591-604.

Stefanou, S.E. and Saxena, S. (1988). Education, Experience and Allocative Efficiency: A Dual Approach. Journal Series Article No. 7692 Pennsylvania Agricultural Experiment Station, 339-345.

Thiam, A., Borris, B.E. and Teodoro, E.R. (2001). Technical Efficiency in Developing Country Agriculture. A Meta-analysis. *Agricultural Economics,* 25: 235-243.

Tijani, A.A., Alimi, T. and Adesiyan, A.T (2006). Profit Efficiency among Nigerian Poultry Egg Farmers: A Case Study of Aiyedoto Farm Settlement, Nigeria. *Research Journal of Agricultural and Biological Sciences,* 2(6): 256-261.