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PROFIT EFFICIENCY AMONG MAIZE PRODUCERS IN OYO STATE, NIGERIA

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ABSTRACT

The study employed a stochastic frontier profit function to measure profit efficiency among maize producers in Oyo State, Nigeria. A multistage random sampling technique was used to select 240 maize producers. The results showed that profit efficiencies of the farmers varied widely between 1% and 99.9% with a mean of 41.4% suggesting that an estimated 58.6% of the profit is lost due to a combination of both technical and allocative inefficiencies in maize production. From the inefficiency model, it was found that education, experience, extension and non-farm employment were significant factors influencing profit efficiency. This implies that profit inefficiency in maize production can be reduced significantly with improvement in the level of education of sampled farmers.

Keywords: maize producers, profit efficiency, factors explaining inefficiency, profit loss.

INTRODUCTION

Maize (*Zea mays*) is a major important cereals being cultivated in the rainforest and derived savanna zone of Nigeria. Maize is one of the popular cereals in Nigeria. Maize is high yielding, easy to process, readily digested, and cheaper than other cereals. It is also a versatile crop; growing across a range of agro ecological zones. Every part of the maize plant has economic value: the grain, leaves, stalk, tassel, and cob can all be used to produce a large variety of food and non-food products.

In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products, while in developing countries, it is mainly used for human consumption. In sub-Saharan Africa, maize is a staple food for an estimated 50% of the population. It is an important source of carbohydrate, protein, iron, vitamin B, and minerals. Africans consume maize as a starchy base in a wide variety of porridges, pastes, grits, and beer. Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled; playing an important role in filling the hunger gap after the dry season (IITA, 2007a). Maize is an important food in Africa and the main ingredient in several well-known national dishes. Examples are tuwon, masara and akamu in northern Nigeria, koga in Cameroon, injera in Ethiopia and ugali in Kenya. It is also used as animal feed and as raw material for brewing beer and for producing starch (IITA, 2008).

In Nigeria, the demand for maize is increasing at a faster rate daily. This may be due to the fact that grain is being used for feeding poultry and also serve as the main food for many household. But the challenge that is currently confronting Nigerian agriculture is low productivity. A number of factors could have been responsible for the low productivity. These include little or no use of improved seeds, herbicides and fertilizers, increased levels of biotic and abiotic constrains and the fact that prices of inputs have tripled in the last ten years. Global warming and its associated effects have changed rainfall pattern leading to erratic and unreliable rainfall in some cases resulting in drought. Furthermore, the little or no use of fertilizers and organic manure has resulted in soil becoming poorer with an opportunistic expansion in Striga infestation problems. Continuous growing of crop for cash also result in build-up and carry over of pests notably stem borers from one crop to the next within the same environment (IITA, 2007b).

Low productivity in maize production has led to increase in the price of maize. According to Akinrinde and Olukotun (2001), if resources are properly managed the yield of maize should range from 1, 120 to 2, 240 kg/ha for early crop and 670 to 1, 123 kg/ha for late crop. However, it appears that maize farmers in Nigeria are not getting maximum return from the resources committed to the enterprise. It is therefore necessary to examine the factors that reduce profit from maize production.

The analysis of efficiency dates back to Knight (1933), Debrew (1951) and Koopmans (1951). Koopmans (1951) provided a definition of technical efficiency while Debrew (1951) introduced its first measure of the 'coefficient or resource utilization'. Following on Debrew in a seminal paper Farrell (1957), provided a definition of frontier production functions, which embodied the idea of maximality. Farrell (1957) distinguished three types of efficiency: (1) technical efficiency, (2) price or allocative efficiency and (3) economic efficiency which are the combination of the first two. Technical efficiency is an engineering concept referring to the input-output relationship. A firm is said to be efficient if it is operating on the production frontier (Ali and Byerlee, 1991). On the other hand, a firm is said to be technically inefficient when it fails to achieve the maximum output from the given inputs, or fails to operate on the production frontier. Mbowa (1996) in his study on the sugarcane industry in South Africa defined an efficient farm as that which utilizes fewer resources than other farms to generate a given quantity of output. Yilma (1996) while studying efficiency among the smallholder coffee producers in Uganda defined an efficient farm as that which produces more output from the same measurable inputs than that one which produces less. Fan (1999) referred to technical inefficiency as a state in which actual or observed output from a given input mix is less than the maximum possible. Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical and allocative efficiencies are components of economic efficiency. It is possible for a firm to exhibit either technical or allocative efficiency without having economic efficiency. Technical and allocative efficiencies are therefore together necessary conditions for economic efficiency.

Following Farrell's (1957) work there has been a proliferation of studies in the field of measuring efficiencies in all fields. But in the field of agriculture, the modeling and estimation of stochastic function, originally proposed by Aigner *et al*., (1977) and Meeusen and van den Broeck (1977) has proved to be invaluable. A critical narrative of the frontier literature dealing with farm level efficiency in developing countries conducted by Battese (1992), Bravo-Ureta and Pinheiro (1993), Coelli (1995) and Thiam *et al*., (2001) indicated that there were wide-ranging theoretical issues that had to be dealt with in measuring efficiency in the context of frontiers and these included selection of functional forms and relevant approaches (parametric as opposed to non-parametric).

Hyuha (2006) investigated profit efficiency among rice producers in eastern and northern Uganda using normalized translog functional form. The results showed area under rice and capital had a positive influence on profit levels while cost of family labor and "other inputs" had a negative effect. The analysis also showed that all farmers were not operating on the profit frontier and scored a mean profit efficiency of 66 percent with about 70 percent of the farmers scoring at least 61 percent. The efficiency levels at the district level were 75, 70 and 65 percent, respectively for Pallisa, Lira and Tororo, respectively.

Rahman (2002, 2003) estimated a stochastic profit function for Bangladesh rice farmers. The results showed that there existed a high level of inefficiency in rice farming because γ was close to one. The average profit efficiency scores were 60%, which implied that the farmers could improve their profitability by as much as 40%. The farmers also exhibited a lot of profit inefficiency. The farm-specific factors responsible were poor access to input markets, unfavorable tenancy arrangements, and off farm employment.

Abdulai and Huffman (1998) examined the profit inefficiency of rice farmers in northern Ghana. The empirical results show that farmers' human capital represented by the level of schooling contributes positively to production efficiency, suggesting that investment in farmers' education improves their allocative performance. Ogundari (2006) investigated factors that determine the profit efficiency among small scale rice farmers in Nigeria. The results showed that their profit efficiency where positively influence by age, educational level, farming experience and household size.

As pointed out by a number of researchers including Akinwumi and Djato (1996, 1997) a profit function is much superior to production function because first it permits straight forward derivation of own-price and cross-price elasticities and output supply and input demand functions, second, the indirect elasticity estimates via profit function have a distinct advantage of statistical consistency, third, it avoids problems of simultaneity bias because input prices are exogenously determined. Akinwumi and Djato (1997) quoting Quismbing (1994) confirm that "problems of endogeneity can be avoided by estimating the profit or cost function instead of the production function". Besides, the profit function is extensively used in literature (Yotopoulos and Lau, 1973; Saleem, 1988; Akinwumi and Djato, 1996 and 1997; Abdulai and Huffman, 2000).

A number of functional forms exist in literature for estimating the profit function which includes the Cobb-Douglas (C-D) and flexible functional forms, such as normalized quadratic, normalized translog and generalized Leontif. The C-D functional form is popular and is frequently used to estimate farm efficiency despite its known weaknesses (Saleem, 1988; Kalirajan and Obwona, 1994; Dawson and Lingard, 1991; Nsanzugwanko *et al*., 1996; Battesse and Safraz, 1998). The translog model has its own weaknesses as well but it has also been used widely (Ali and Flinn, 1989; Wang *et al*., 1996). The main drawbacks of the translog model are its susceptibility to multicollinearity and potential problems of insufficient degrees of freedom due to the presence of interaction terms. The interaction terms of the translog also don't have economic meaning (Abdulai and Huffman, 2000). The objective of the study therefore was to examine the profit efficiency among maize producers in Oyo State, Nigeria.

MATERIALS AND METHODS

The data used in this study were based on the farm level study of maize farmers in Oyo State of Nigeria. Oyo State is located between latitudes $2^o\ 38^1$ and $4^0\ 35^1$ east of the Greenwich meridian. Oyo State covers an area of 28, 454 square kilometer (FOS, 1996). According to NPC (2006), Oyo State had a population of 5,591,585. The state has two distinct ecological zones - the western rain forest to the south and the intermediate savannah to the north. The state is divided into four agricultural zones. These are Ibadan/ Ibarapa, Oyo, Ogbomoso and Saki agricultural zones. Agriculture is the main occupation of the people and small scale traditional farming system predominates in the area.

The four agricultural zones were taken as the sampling units as a first stage of sampling. At the second stage, one local government areas were randomly selected to represent the zone making a total of four LGAs. The last stage involved random selection of sixty (60) maize farmers in each local government area making a total of 240 respondents. Data were collected with the use of a structure questionnaire to collect input-output data of the farmers. Data were analyzed using descriptive statistic and Tran slog frontier profit function model.

Model specification

$$\ln \pi' = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln p_i + \tfrac{1}{2}\sum_{i=1}^{3} \sum_{k=1}^{3} r_{ik} \ln p_i \ln p_k + \sum_{i=1}^{3}\sum_{l=1}^{2} \phi_{il} \ln p_i \ln z_l + \sum_{l=1}^{2} \beta_l \ln z_l + \tfrac{1}{2}\sum_{l=1}^{2}\sum_{q=1}^{2} \varphi_{lq} \ln z_l \ln z_q + \nu - \mu \quad (1)$$

where

$$\mu = \delta_0 + \sum_{d=1}^{6} \delta_d w_d + \vartheta \quad (2)$$

$r_{ik} = r_{ki}$ for all k, i

π' restricted normalized profit computed for jth farm defined as gross revenue less variable costs divided by farm specific maize price p_j.

ln = natural log

p_i = price of variable inputs normalized by price of output where (for i =1, 2, and 3)

so that:

p_1 = the cost of hired labor normalized by price of maize (p_y)

p_2 = the cost of seed normalized by price of maize (p_y)

p_3 = Imputed cost of "other inputs" normalized by the price of maize (p_y)

z_l = the quantity of fixed input (l = 1, 2)

where

z_1 = land under maize (hectares under maize) for each farm j

z_2 = capital used in farm j.

μ = inefficiency effects

ϑ = truncated random variable

δ_0 = constant in equation 2

ω_d = variables explaining inefficiency effects and are defined as follows:

ω_1 = education

ω_2 = experience

ω_3 = household size

ω_4 = extension services

ω_5 = non-farm employment

α_0, α_i, r_{ik} ϕ_{il}, β_l, φ_{lq}, δ_0 and δ_d, are the parameters to be estimated.

Profit loss due to inefficiency was then calculated as maximum profit at farm - specific prices, fixed factors, and soil dummies multiplied by farm- specific profit inefficiency. Profit loss is defined as the amount that has been lost due to inefficiency in production given prices and fixed factor endowments and is calculated by multiplying maximum profit by (1-Pe).

Maximum profit per hectare is computed by dividing the actual profit per hectare of individual farms by its efficiency score.

PL = maximum profit (1-PE)

where

PL = profit loss

PE = profit efficiency

RESULTS AND DISCUSSIONS

In this section, the results of the estimates of parameters of the stochastic translog profit function, factors affecting inefficiency and profit loss are presented and discussed.

Estimation of frontier profit function: translog model

The maximum likelihood estimates of the parameters of the stochastic profit frontier model are presented in Table-2. The dependent variable was restricted profit from an output of one season. All the estimated coefficients carry the theoretically expected signs in the MLE model and are statistically significant. This implies that all the variables are influential variables in maize production. Area under maize affects profit efficiency positively.

The estimated value of γ is chose to 1 and is significantly different from zero thereby establishing the fact that a high level of inefficiencies exists in maize production. The estimated gamma parameter (γ) of 0.999 was highly significant at 1 percent level of significance. This implies that 99.9 percent of variation in actual profit from maximum profit (profit frontier) between farms mainly arose from differences in farmers' practices rather than random variability.

Factors explaining inefficiency

The purpose was to determine factors that explain profit inefficiency. The variables included in the model were in line with theory. These are education, experience, household size, extension services and non-farm employment.

The results in Table-4 showed that the estimated coefficient on education is negative and statistically significant indicating reduction in profit inefficiency. This implies that to an extent more education brings about decrease inefficiency (increase in efficiency) in maize production. This also indicates that farmers with more years of schooling incur significantly higher profit efficiency than farmers with less years of schooling. These results are consistent with Ali and Flinn (1989), Abdulai and Hoffman (2000) and Kumbhakar and Bhattarcharya (1992).

The estimated coefficient associated with experience, carries the expected negative sign and is statistically significant at 5 percent level. The result implies that those with experience are better performers than those without. In other words, maize farmers with more years of experience tend to operate at significantly higher level of profit efficiency.

The estimated coefficient associated with the extension services is significant in the study area. This result reveals that farmers who have access to extension services perform significantly better in operating at higher level of efficiency. This result is also consistent with findings obtained by other researchers (Seyoum *et al*., 1998; Rahman, 2002; Hyuha, 2006). This result therefore serves to emphasize the role of extension services in reducing profit inefficiency in maize production.

The positive and significant coefficient of the non-farm employment variable indicates that farmers who engaged in non-farm activities operate at significantly lower levels of efficiency. Rahman (2003) reported similar result for rice farmers in Bangladesh.

Profit efficiency score estimates

The frequency distribution of farm- specific efficiency scores for the maize farmers is shown in Table-3. The findings showed that maize farmers achieved on average 41 percent level of efficiency. This implies that the average farmer in the study area could increase profit by 59% by improving their technical and allocative efficiency. The maize farmers exhibit a wide range of profit inefficiency ranging from 1% to 99%. It is worthy noting, however, that this wide variation is not unique to Nigeria, similar results have been reported by other researchers else where. Ali and Flinn (1989) obtained a minimum of 13 percent and a maximum of 9.5 percent for rice farmers of Gujranwala district, Pakistan. Wang *et al*., (1996) reported efficiency levels ranging from 6 percent with a mean of 62 percent for rural farm households in China.

Profit loss in maize production

The inefficiency translated into a profit loss ranging from ₦53.61k to 178, 601.60k with a mean of 18, 381.84. This could be recovered by eliminating technical and allocative inefficiency (Table-4).

Table-1. Summary statistics of variable.

Parameters	Mean	Minimum	Maximum	Standard deviation
Gross margin (₦)	115987.54	245.63	714432.00	137846.58
Seed cost (₦ /kg)	86.16	15.00	200	43.63
Labor cost (₦ /ha)	9762.54	1389.00	35,00	7161.50
Farm size (ha)	2.13	1	4	0.69
Fertilizer cost (₦/ha)	9147.81	4750	17200	3014.25
Herbicide cost (₦/ha)	1993.25	700	12400	1837.13
Equipment (₦)	1205.26	127	4850	985.74
Education (years)	9.21	3	15	3.42
Experience (years)	23.54	5	50	12.02
Household size (years)	9.03	3	18	3.67

Source: Survey, 2009.

Table-2. Maximum likelihood estimates of translog profit frontier function.

Variable	Parameter	Coefficient	t-ratio
Profit Function			
Constant	α_0	63.253	55.267
In P_1	α_1	-1.607	- 3.731 xxx
In P_2	α_2	-3.925	- 4.045 xxx
In P_3	α_3	-2.105	- 6.296 xxx
In Z_A	β_A	6.220	7.981 xxx
½ In Z_B	β_B	-2.453	- 9.010 xxx
½ In P_1^2	Γ_{11}	-0.351	- 9.417 xxx
½ In P_2^2	Γ_{22}	0.031	0.703
½ In P_3^2	Γ_{33}	-0.030	- 0.331
½ In P_A^2	θ_{AA}	-1.407	- 3.859 xxx
½ In $P_{\mathbf{B}}^2$	θ_{BB}	-0.715	- 10.788 xxx
In P_1 x In P_2	Γ_{12}	-0.030	- 0.657
In P_1 x In P_3	Γ_{13}	-0.728	- 2.444 xx
In P_2 x In P_3	Γ_{23}	-0.701	- 2.643 xxx
In P_1 x In Z_A	$\varnothing_{1A}$	0.095	0.464
In P_1 x In P_B	$\varnothing_{1B}$	0.268	1.823 x
In P_2 x In Z_A	$\varnothing_{2A}$	-0.079	- 0.616
In P_2 x In Z_B	$\varnothing_{2B}$	-0.629	- 0.918
In P_3 x In Z_A	$\varnothing_{3A}$	1.734	4.248 xxx
In P_3 x In Z_B	$\varnothing_{3B}$	-1.411	- 4.377 xxx
In Z_A x In Z_B	θ_{AB}	-0.412	- 2.245xx
Variance parameters	**Parameter**	**Coefficient**	**t-ratio**
Sigma - square	σ^2	2.695	6.265xxx
Gamma	Γ	0.999	7.890xxx
Log likelihood		-139.057	
Inefficiency Effects			
Constant	δ_0	2.088	2.138xx
Education	δ_1	-0.179	- 2.643 xxx
Experiences	δ_2	-0.019	- 1.975 xx
Household size	δ_3	-0. 083	- 1.323
Extension	δ_4	-0.086	- 3.026 xxx
Non Farm Employment	δ_5	0.127	1. 779 x

Source: Result from data analysis, 2009.

Table-3. Deciles frequency distribution of profit efficiencies of maize farmers.

Efficiencies	Frequency	Percentage
< 0.5	156	65.0
0.5 - 0.59	18	7.5
0.6 - 0.69	14	5.8
0.7 - 0.79	12	5.0
0.8 - 0.89	24	10.0
0.9 - 99	16	6.7
Total	240	100
Mean	0.414	
Minimum	0.011	
Maximum	0.999	
Std. Deviation	0.297	

Source: Data analysis, 2009.

Table-4. Frequency distribution of profit loss in maize production.

Efficiencies	Frequency	Percentage
1 - 5000	96	40.0
5001 - 10000	38	15.8
10001 - 15000	30	12.5
15001 - 20000	18	7.5
20001 - 25000	10	4.2
25001 - 30000	0	0
> 30000	48	20.0
Total	120	100
Mean	18381. 84	
Minimum	53.61	
Maximum	178601.60	
Std. Deviation	26876.16	

Source: Data analysis, 2009.

CONCLUSIONS

This paper used stochastic translog profit frontier model to examine profit efficiency among maize farmers in Oyo State of Nigeria using farm level data obtained from 240 maize producers. The study showed that profit efficiency varied widely among the sampled farmers. It ranged from 1% to 99% with a mean of 41%. The mean level of efficiency indicates that there exists room to increase profit by improving the technical and allocative efficiency. Among those factors that have significant impacts on profit efficiency are education, experience, extension and non farm employment. The policy implication in maize production of these finding is that inefficiency in maize production can be reduced significantly by improving the level of education among the farmers and awareness by extension agents. Most important are the extension services and the existing technological packages that need to be critically examined.

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